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COMPARISON OF FIXED WING AIRCRAFT ALGORITHMS FOR JANUS

by

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Comparison of Fixed Wing Aircraft Algorithms for JANUS

by

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This research compares the fixed wing altitude algorithms utilized in the United States and the Australian versions of the combat modeling tool, JANUS(A). The Australian Army Battle Simulation Group has recently developed a new algorithm that more realistically models aircraft flight profiles within JANUS(A). A Low-High-Low strike profile was simulated, using both algorithms, against low level, littoral anti-aircraft weaponry. The simulated aircraft were flown in a weapons hold environment and number of detections were recorded over the entire strike route as the principal MOE. The simulated aircraft were then subjected to a weapons free environment where engagement data was compiled. The Australian algorithm enabled the operator to alter aircraft altitude and speed during the simulation on command. The ability to alter altitude and speed are essential to accurately modelling tactical evasive manuevers. These alterations are not features incorporated in the present U.S. version of JANUS(A). Analysis indicates this controllability not only reduced the number of detections significantly, but also increased aircraft survivability within the strike environment. Both of these phenomenon are expected outcomes of such evasive actions. This work also provided the basis for future work that could incorporate virtual simulation with JANUS(A).

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This research compares the fixed wing altitude algorithms utilized in the United States and the Australian versions of the combat modeling tool, JANUS(A). JANUS(A), in its most limited mode, is a battalion level battle simulation used for training and performance analysis of numerous battle scenarios. As a tool for ground combat maneuvers and tactics, JANUS performs extremely well. The problem that this work addresses is the model's inability to simulate fixed wing aircraft accurately. The Australian Army Battle Simulation Group, located in Georges Heights, New South Wales, has recently developed a new algorithm that more realistically models aircraft flight profiles within JANUS(A). This algorithm provides two significant improvements to the current U.S. algorithm.

The first improvement involves the ability to select two separate altitude types, above ground level (AGL) and mean sea level (MSL). Since JANUS(A) was not originally intended to simulate fixed wing aircraft, only the AGL altitude was incorporated for rotary wing aircraft representation. The AGL altitude mode is accurate for rotary aircraft because most of their operations are conducted below 5000 feet and helicopters tend to follow the contours of the terrain. This type of flying allows the helicopter to utilize the terrain as a masking device and thus reduce detection. Although scenarios exist that require fixed wing aircraft to

operate at low altitude, they primarily operate at altitudes well above 5000 feet. At high altitudes , fixed wing aircraft can fly level to conserve fuel while remaining outside of enemy air defense envelopes.

The second improvement allowed the operator to alter the simulated aircraft's altitude on command. The operator could select any new altitude for the simulated aircraft to fly as long as it was between 0 and 99000 feet. The current U.S. version does not incorporate this feature. Instead, the operator is limited to two predetermined altitudes that are set prior to game's execution. Although both algorithms incorporate immediate altitude changes, the Australian version allows the operator to change altitude incrementally, thereby representing climb and descent rates more accurately.

To evaluate the performance of each algorithm, a low level, littoral threat scenario was created . Simulated F-18 Hornet aircraft strikes were flown against enemy anti-aircraft batteries. The simulated aircraft were subjected to two weapon status environments, weapons hold and weapons free. The number of detections were recorded over the entire strike route as the principal measure of effectiveness for the simulated aircraft in the weapons hold environment. The simulated aircraft were then subjected to a weapons free environment where engagement data was compiled.

The analysis of the data showed that the mean number of detections against the simulated blue aircraft, flying the Australian profile, were less than the runs utilizing the U. S. algorithm. Although the remaining tests did not show significant statistical differences in flight profiles, Janus AAW algorithms appear to perform accurately. Aircraft that were subjected to enemy anti-aircraft weapon envelopes for a longer duration were detected, engaged and killed at a higher rate.

The ability to alter altitude and airspeed are essential to accurately modelling tactical fixed wing maneuvers. These alterations are not features incorporated in the present U.S. version of JANUS(A). Analysis indicates this controllability not only reduced the number of detections significantly, but also increased aircraft survivability within the strike environment. Both of these phenomenon are expected outcomes of such evasive actions. The next logical progression in the development of improved fixed wing altitude algorithms for JANUS(A) is the incorporation of climb and descent rates for the simulated aircraft. This task is near completion at the Georges Heights facility and may provide the bases for further research in this area.

I. INTRODUCTION

A. BACKGROUND

The current National Military Strategy stresses the importance of Joint force implementation and cooperation to maintain a strategic edge in the New World Order [Ref. 1]. Desert Storm provided the testing ground for this structure and although Operation Desert Storm proved to be a resounding success, several lessons concerning Joint Warfare were learned. The prominent flaw of Joint warfare was and still remains the lack of Joint training. Theater warfare training involving Air Force, Army, and Navy personnel is limited and expensive. If Joint Warfare Operations are going to be the backbone of National Military Strategy then less expensive means for training must be utilized.

Some tools utilized to offset the cost of live warfare training are models and simulation. The Army's model Janus(A) is used for this purpose. This model, in its most limited mode, is a battalion level battle simulation used for training and performance analysis of numerous battle scenarios. However, the upper limit of this model's capabilities has yet to be realized. One aspect that must be incorporated into this model involves the accurate participation of fixed wing aircraft.

B. MOTIVATION

In 1991, the U.S. Army Training and Doctrine Command selected Janus(A) as the simulation software standard for training. The Janus (A) model is fielded throughout the world and, due to its ability to accurately model complex combat scenarios, is widely utilized as a training and analytical tool in numerous applications which include, combat training, studies of combat operations, combat development, testing of new equipment, and research and development. [Ref. 2:p. 1]

Despite the successes displayed by Janus(A), the incorporation of fixed wing aircraft, referred to as "fast movers" has been minimal. First of all, since this model is primarily a tool utilized by Army ground personnel on the Battalion, Company and Platoon levels, initially the necessity to accurately portray fixed wing aircraft was a secondary concern. Now that Joint Training and cooperation is the focus of National Military Strategy, the Army has taken steps to improve Janus(A) to include other service platforms and capabilities.

An integral step in developing Janus(A) into a model where Joint participation can occur, involves realistically implementing "fast movers." Fixed wing aircraft have been included into the Janus(A) model since 1989 with little flight characteristic control or performance accuracy. Several key deficiencies exist in the Janus(A) fast mover algorithms. The primary deficiency is the lack of speed and altitude control throughout the battle scenario. The current algorithm allows the aircraft to remain at two predetermined altitudes and speeds throughout the battle simulation. The aircraft is unable to vary altitude and speed in the target area, thus, reducing internal capabilities of escaping or evading enemy weapon systems. The Janus(A) simulation regards the fixed winged aircraft simply as a helicopter that does not hover, but proceeds between nodes at a constant speed and altitude. [Ref. 3:p. 2]

Modifications to the altitude and airspeed algorithms would allow operators to react and perform tactically accepted maneuvers during a battle sequence. As a result, the Janus(A) simulation would become more dynamic and accurate in the representation of combat air support and battlefield air interdiction missions.

Presently, the Australian Army has developed algorithms for Janus(A), version 2.0, that allow the operator to control altitude and airspeed parameters throughout the battle simulation. These algorithms have been tested at the Army Battle Simulation Group facility in Georges Heights, Australia, but have yet to be incorporated into the U.S. Army's version.

C. OBJECTIVES

The primary objective of this work involves a direct comparison between the existing U.S. Janus fixed wing algorithms and the newly developed Australian algorithms. The subsequent findings will then be evaluated utilizing statistical models to determine if a significant difference between the two algorithms exists. To accomplish this objective, several steps must be completed prior to analysis: (1) A Janus scenario consisting of fixed wing aircraft, anti-aircraft weapons platforms, and anti-aircraft radar systems must be developed for comparative analysis between the differing algorithms. (2) Several simulations must be executed, varying aircraft altitude, to evaluated the performance of fixed wing aircraft utilizing the two separate algorithms.

D. CHAPTER SUMMARY

Chapter II provides an overview of the Janus(A) simulation system, including background on the development, a brief description of the model, and the hardware and software required to operate the system. The chapter describes the subroutines required for fixed wing aircraft movement within the U.S. Janus model and the subroutines utilized for red anti-aircraft weapon detections and engagements.

Chapter III addresses aircraft profiles and basic aviation definitions. The chapter denotes the differences between the U.S. and Australian fixed wing algorithms and includes the improvements made by the Australians. Finally, the chapter lays the foundation for strike profile development in the Janus environment.

Chapter IV addresses scenario development and methodology used for data collection.

Chapter V contains the data analysis portion of this work. This chapter evaluates the differences between the two fixed wing algorithms.

Chapter VI provides guidance on future improvements of Janus(A) fast mover algorithms. The chapter draws conclusions from the data analysis performed in the previous chapter and makes recommendations for future developments.

II. JANUS(A) OVERVIEW

A. BACKGROUND

Janus, since its inception in the late 1970's, has evolved into a widely utilized, interactive, computer based, war-gaming simulation that models brigade level combat operations for the United States Army. Originally, the Janus simulation was developed at the Lawrence Livermore National Laboratory (LLNL) to model nuclear effects and perform tactical training. Later, the U. S. Army TRADOC Analysis Command, White Sands Missile Range, New Mexico (TRAC-WSMR), acquired this prototype from LLNL as a result of the Janus acquisition and Development Project, directed by the U.S. Army Training and Doctrine Command (TRADOC) in 1980. In 1983, TRAC-WSMR adopted Janus and further developed it as a high resolution simulation to support analysis for Army combat developments. [Ref. 2:p. 4]

The original version, developed at LLNL is known as Janus(L), while the model developed by TRAC-WSMR is known as Janus(T). Subsequent to their development, both of these models gained in popularity and employment by a varied number of users, which led to a wide proliferation of different versions of both models. The Janus(Army) Program began in 1989 to solve the standardization problem and to field a single version, Janus(A), for all Army users. Today, Janus(A) is developed, maintained, and distributed by TRAC-WSMR, and is fielded throughout the world as a tool for both trainers and analysts in research and development, testing, and combat development. [Ref. 2:p. 4]

B. DESCRIPTION

Janus(A) is a two sided, interactive, closed, stochastic, ground combat simulation. It is termed two sided because it allows the simulation of two opposing forces. These two forces, the Blue force and the Red force, are simultaneously directed and controlled on separate monitors by two different sets of players. Each monitor displays only the vehicles pertaining to its side, plus the opposing vehicles which are directly observed by its vehicles. Therefore, the model is classified closed because the friendly force player does not know the complete disposition of the opposing forces. The model is interactive because each player monitors, directs, reacts to, and redirects all key actions of the simulated units under his control. Once a scenario is started, certain events in the game, such as direct fires and artillery impacts, are stochastically modeled, which means that they act according to the laws of probability, and thus are different for every scenario run. The principal modeling focus in Janus(A) is on military systems that participate in maneuver and artillery operations on land, thus the term ground combat simulation. [Ref. 2:p. 5]

The current Janus(A) version is 4.0, but this project utilizes Janus(A) version 2.0. The reason for version disparity is that the Australian Army developed the fixed wing algorithm in the 2.0 format. As newer versions become available to the Australian Army and if the algorithms involved are significantly better than the U.S. algorithms, the algorithms could be transitioned to an upgraded version of Janus.

C. HARDWARE

Janus(A) currently runs on any Digital Equipment Corporation (DEC) VAX family of computer systems utilizing the standard VMS operating system. In August 1991, the Army directed that Janus(A) be fielded on an "open system". Since then, it has been successfully demonstrated on UNIX based X-workstations, and has been benchmarked as an open system for incorporation into the system August 1992 [Ref. 4]. This project will be executed on VAX terminals and displayed on Tektronics monitors.

D. SOFTWARE

Janus(A) is composed entirely of Army-developed algorithms and data to model the combat process. The multitude of programs which belong to Janus(A) consist of approximately 200,000 lines of code written entirely in VAX-11 FORTRAN, a structured Digital Equipment Corporation (DEC) extension of ANSI standard FORTRAN-77. In addition to these combat simulation programs, Janus(A) also has eleven utility programs to facilitate the creation, running, and after-action analysis of a specific scenario. [Ref. 2:p. 5]

In Janus, there exist two major components in aircraft modeling. The first involves aircraft movement and the second is the search and target engagement process. [Ref. 3:p. 2] Since this work is focusing on the performance of fixed wing aircraft in a strike environment, only the aircraft movement subroutines will be addressed.

In addition, the subroutines required by the opposing, red force's anti-aircraft weaponry will also be included.

E. AIRCRAFT MODELING WITHIN JANUS 2.0

As mentioned in the introduction, the original intent of Janus was to model ground combat with a nominal focus on helicopter representation. The system was neither designed nor claimed to adequately simulate fixed wing aircraft; however, research has shown that Janus does an adequate job of modeling helicopter effects. Although it can be said that Janus plays fixed wing aircraft, the simulation really models the aircraft as helicopters. The only difference is that fixed wing aircraft do not " pop up" or hover, but rather, fly at a constant speed and constant altitude above ground over a preplanned designated route. [Ref. 3:p. 2]

Until movement commences, fixed wing aircraft are assumed to be on the ground at some form of airfield. Once airborne, aircraft movement is accomplished over preplanned routes, designated by the player, consisting of nodes connected by straight line segments.

Air routes are identical to ground routes except aircraft ignore terrain effects (e.g. slope, foliage, blowdown). Aircraft fly between nodes at either of two user input constant velocities and above ground level (AGL) altitudes: low and slow (NAP1) and high and fast (NAP2). This method of flight is commonly referred to as Nap of the Earth. Since aircraft are limited to two predetermined altitudes, the operator can only descend or ascend immediately from "High" to "Low" or "Low" to "High". For example, if an aircraft is ingressing at 500 ft, and desires to ascend for weapons release at 10,000 ft, the subsequent change of 9500 ft is immediate.

Nodes along the route are designated as stop/hold or go nodes. Helicopters hover at the stop nodes until the player designates the helicopter to "pop up". If, during the setup/planning phase, a prepared fighting position (PREPOS) has been placed at a stop node, the helicopter will automatically pop-up when it reaches the node, and will remain popped up for a "maximum pop time" as defined in the Janus database. Fixed wing aircraft will land if they reach a stop node. Helicopters will land when they reach the last node on the route. [Ref. 3:p. 2]

Janus permits up to 32 aircraft types to be selected by the operator. Seven key aircraft characteristics are input for each aircraft type: NAP1 altitude, NAP2 altitude, hover altitude, NAP1 velocity, NAP2 velocity, maximum pop time, and mast height. These entries can be manipulated in the data base. By adjusting the values of the fields, numerous types of aircraft can be represented with varied capabilities. Since fixed wing aircraft are not differentiated from helicopters in the Janus code, the data field hover altitude and maximum pop time are left blank. This is how the Janus code will determine that an aircraft is not a helicopter and thus treat the unit as a fixed wing aircraft.

Additionally, a type number (1-32) determines which of three general categories that an aircraft can be assigned. The three categories are normal/nonscanning, types (1-26), special/scanning, types (27-31), and special-special, type (32). These categories determine how the helicopter pops up and engages targets. Fixed wing aircraft are designated a type 1 through 26, with no hover altitude or maximum pop time input. [Ref. 3:p. 3]

For completeness, a discussion of the three categories follows, although it applies to rotary wing aircraft only.

- Normal/non-scanning, types (1-26): This category of aircraft remains popped up the "maximum pop time", engages targets while popped, and stays popped until the round impacts. If it engages a target, it immediately heads for the next node when it pops down. If it cannot find a target in maximum pop time, it pops down and repeats the cycle.
  Note: type 3 is reserved for FOGM Helos.

- Special/scanning, types (27-31): This category of aircraft pops up for a fixed length of time ("snapshot time"). During this time, it stores target data and is exposed. It remasks immediately at the end of the snapshot time and stays masked (for a time proportional to sensor field of view). This masked time models the pilot searching the stored picture for targets. If no targets are found, the aircraft pops up and repeats the cycle. If targets are found, it engages during the next popup and stays up for "maximum popup time" or until the fired round impacts, whichever is longer. It then moves toward the next node. The cycle repeats until the special flyer either finds targets and engages them or the player takes it out of pop up mode.

- Special-special, type (32): Similar to special/scanning except it does not have to wait for the fired round to impact before popping down. [Ref. 3:p. 3]

During the following discussion, please refer to Figure 1 for the hierarchial flowchart of the routines called for the aircraft movement logic. Janus utilizes a routine called RUNJAN as the event driver or main scheduler. RUNJAN determines the next scheduled

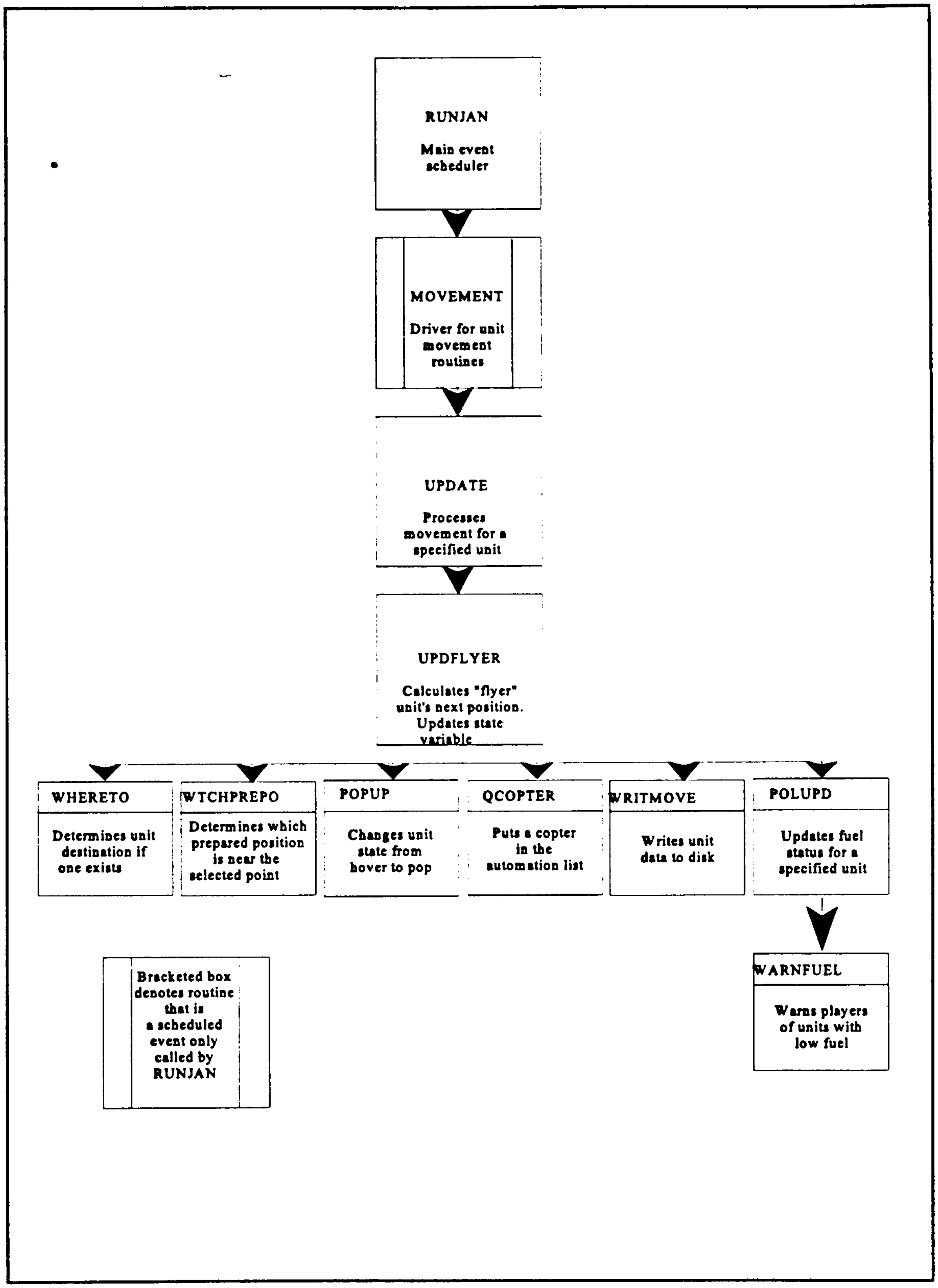

Figure 1 Aircraft Movement Logic

process, whether it is a movement or search, advances the game clock and calls the appropriate routine to execute the process. [Ref. 5:p. 559]

The subroutine involving aircraft movement, which RUNJAN executes, is MOVEMENT. UPDFLYER is the workhorse routine that calculates when and how an aircraft will move. It is called by routine UPDATE which is called by routine MOVEMENT (really an event) which is called by RUNJAN every DTMOVE seconds. The variable DTMOVE controls updates for all units, so it determines ground as well as aircraft update frequency. Routine MOVEMENT is called alternately for each side, to update the location of all units on a side. Since DTMOVE is set in RUNJAN to 1.0 seconds, each unit on a side is updated every two seconds. Routine MOVEMENT cycles through all the units on a side, calling routine UPDATE which in turn calls UPDFLYER for aircraft. [Ref. 5:p. 596]

If the flyer is inoperative because of chemical dosage, UPDFLYER updates the movement parameters and exits. UPDFLYER next gets the unit current location and calls routine WHERETO to determine where the unit's objective (next node) is. WHERETO does the following:

- If the unit has reached a stop/hold node (i.e. there is no "objective") it sets the variable, IPREPO, to 1, and XOBJ and YOBJ to the unit's current location.
- If there is a valid move to a next node (i.e. unit has an objective) XOBJ and YOBJ are set to the x, y of next node and IPREPO is set to 0.

If IPREPO is 1, UPDFLYER calls ATPREPO to see if a prepared position is near. If there is a prepared position near, POPUP is called to put the unit in popup mode and QCOPTER is called to initialize parameters for the popup logic. UPDFLYER next resets the unit's speed and time to move and calls POLUPD to update its fuel status. The routine is then exited. [Ref. 3:p. 5]

If XOBJ and YOBJ are equal to current unit location and there are no prepared positions, the unit is either in a stop/hold node or the last node, and no location change is necessary. Therefore, speed is set to 0 and DT (next unit update) is set to 1/3. Helicopters will hover at a stop/hold node until the player directs it to pop up or changes the node to a go node. Fixed wing must land at a stop/hold node. The routine is then exited.

If XOBJ and YOBJ are not equal to current unit location, UPDFLYER moves the unit using the following logic:

- Determine the distance between the unit and its objective (next node).
- Get the unit speed for the next time interval based on the current flight mode.
- Calculate the maximum distance to travel in <u>two seconds</u> (based on the unit's speed).
- Set the distance to travel to the smaller of the distance to the objective or the maximum distance.
- Set the unit formation to on-line and call WRITMOVE to record the unit location to disk.
- Save the last time of movement.
- Call routine POLUPD to update the fuel remaining. POLUPD calls routine WARNFUEL if the aircraft is getting low on fuel (1/8 tank), and routine WARNFUEL sends a low fuel warning to the player.
- Exit the routine. [Ref. 5:p. 597]

As a summary note, if all nodes are "go" nodes, the aircraft will just fly the entire route without stopping or popping up and it will engage targets of opportunity along the way. Fixed wing have to land if they reach a stop node. All aircraft land when they reach the final node.

F. ANTI-AIRCRAFT MODELING WITHIN JANUS 2.0

The procedure in which an anti-air weapon searches and engages fixed wing targets in Janus will be discussed in the following paragraphs. During the discussion, refer to Figure 2 for the hierarchial flowchart of the routines called for the AAW search and acquisition logic.

The RADAR subroutine transitions an air defense radar from its current state to the next appropriate state. A target is considered "detected" if two out of three scans result in Single-Scan Detections (SSDs). The logic is as follows:

- If the radar type is "normal", and the target detected this time is not the same as last scan, update pointers and exit subroutine.
- If the radar type is "special" and it is moving, clear target list, clear automation slots, update pointers and exit subroutine.
- If there are no countable SSDs, clear target list, update pointers and exit subroutine.
- If radar is RED, then call REDADFDET to determine Pd for this scan.[Ref. 5:p. 548]

At this point of the subroutine, the system calls for a random number that is in turn used for Pd calculations. If all conditions within the RADAR subroutine are met, then WTDETEC is called to record the detection event. Once this detection is recorded and if the radar is RED, then REDADFTRK is called and the logic is as follows:

- REDADFTRK sets the detect-to-track processing delay. If the time to track is non-negative, schedule the time to complete track and set radar status to "enemy detected, track not achieved."
- A negative time indicates track failure.
- If probability to track is greater than zero, then make radar re-detect the target next scan unless jammed. [Ref. 5:p. 552]

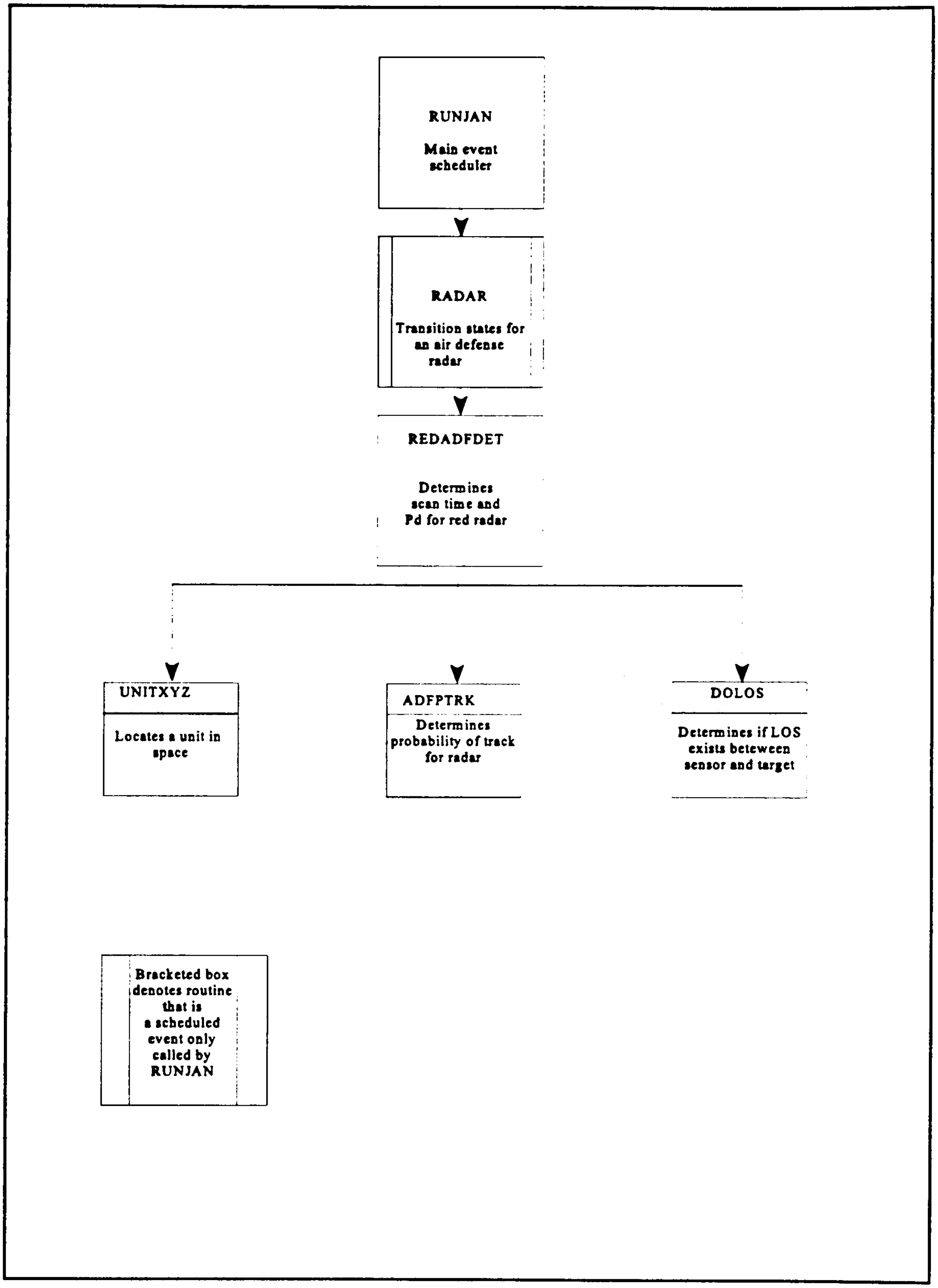

Figure 2 AAW Search and Acquisition Logic

Once REDADFTRK is called by RADAR, it determines the scan time and the probability of detection (for one scan) of an air defense radar unit against a flyer target unit. The logic is as follows:

- Get the radar scan time and the target's flying mode. If the target is on the ground, then no detection can take place, exit the subroutine.
- Call UNITXYZ to get the positions of the radar and the target. Calculate the range and altitude from the radar to the target.
- If the target is moving, call DOLOS to check the LOS. If LOS has been lost, exit the subroutine, otherwise call ADFPTRK. [Ref. 5:p. 552]

This brief overview addresses some of the routines and modeling techniques involved in the Janus fast mover development. The Software Programmer's Manual for Janus consists of over one thousand pages of routine and subroutine references. The following section will discuss and include the Australian developments and flight profile developments for this work.

III. AUSTRALIAN MODIFICATIONS AND PROFILE DEVELOPMENT

A. BACKGROUND

The first aspect of developing an improved algorithm for fixed wing aircraft involves an understanding of basic aviation profiles. At present, the Janus(A) algorithm plays fixed wing aircraft at above ground level (AGL) altitudes opposed to mean sea level (MSL) altitudes. This construct is inaccurate since typical aircraft profiles are a mixture of AGL and MSL altitudes. Figure 3 below gives a pictorial definition of the two altitude types.

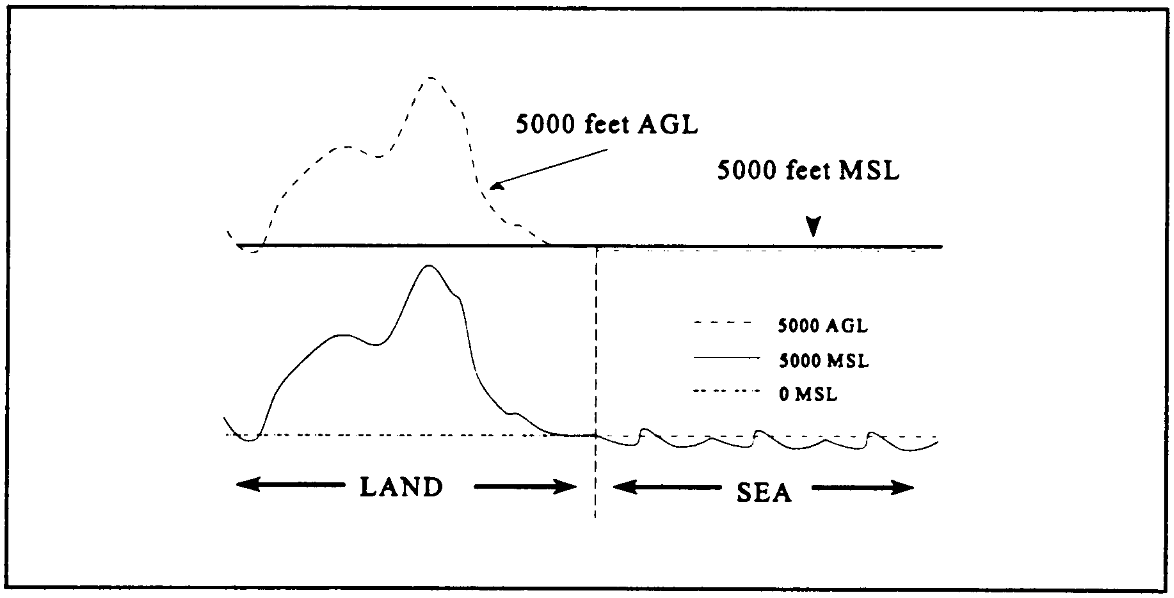

Figure 3 Graphical Definitions of MSL and AGL Altitudes

Fixed wing aircraft use two methods to maintain altitude -- the barometric altimeter and the radar altimeter. The barometric altimeter provides altitude information based on current barometric pressure in the area of operation. This altitude is MSL and does not change as terrain changes. The radar altimeter is an AGL altitude instrument. The pilot utilizes this altimeter when operations require AGL altitudes of 5000 feet or less. This altitude, AGL, does change with the terrain of the earth.

For the strike operations modeled in this work and practiced throughout the aviation community, it is necessary to have the option of flying at MSL or AGL altitudes. The flight path of a typical strike aircraft flying what is referred to as a low-high-low profile is represented in the following diagram.

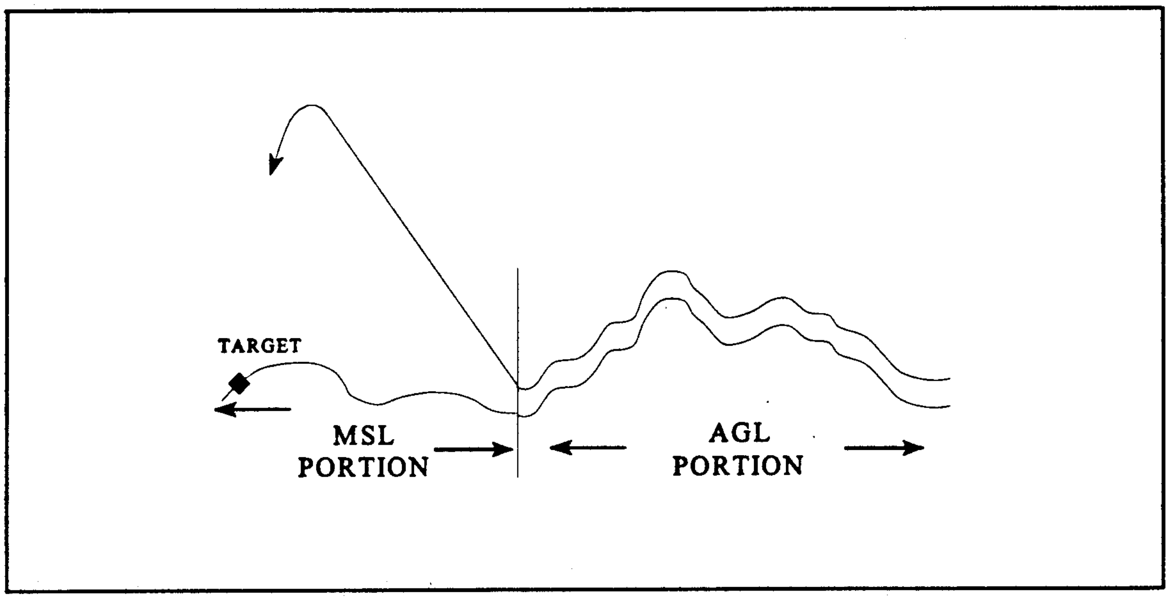

Figure 4 Strike Profile

The U.S. Army's version of Janus(A) flies at AGL altitudes exclusively and as mentioned previously, altitude changes between the two predetermined inputs altitudes occur instantaneously.

Contrary to the U.S. Army version, the Australian version of Janus(A) allows the player to select either MSL or AGL altitudes throughout the game play. Furthermore, the operator can vary airspeed during the simulation. The Australian version is not limited to two altitudes or two airspeeds. Both these parameters can be altered on the fly, thus allowing the operator to maneuver the aircraft in accordance with a specified tactic.

Referring to the example above, the aircraft could ascend from an altitude of 500 feet AGL to 10,500 feet MSL at a rate selected by the operator. The only limitation at this point in time is that altitude changes have to be input by the player each time a change in altitude is required. Figure 5 demonstrates the difference in the "strike profile" of the two systems.

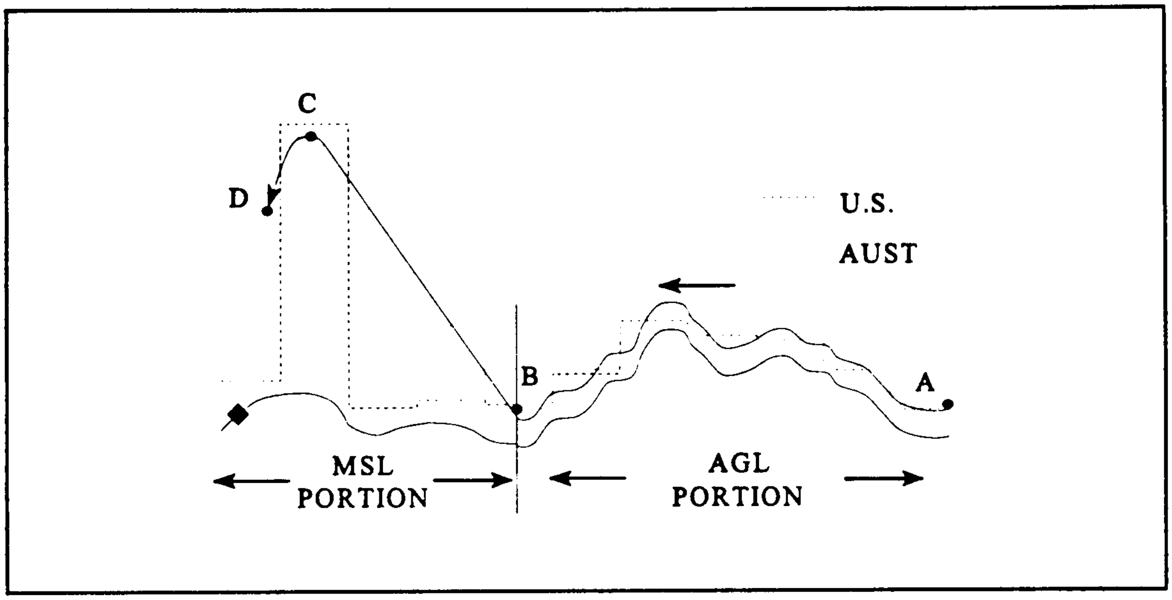

Figure 5 Strike Profile Representation

From point A to point B, both algorithms perform in the same manner due to the nature of the AGL flight path calculating the mean altitude over a predetermined range.

During the next phase, point B to point C, the simulated aircraft using the U.S. algorithm maintains his current AGL altitude until the player decides to increase his altitude. An immediate ascent to the predetermined "high" altitude occurs. The Australian algorithm, on the other hand, is capable of stepping through MSL altitudes to the final roll over point where the aircraft would prepare for weapons delivery. The step size is restricted by the number of altitude updates the operator wants to input [Ref. 6]. By increasing the number of ascent or descent points, the operator can get closer to the straight line climb curve of the actual aircraft.

During the final phase of the profile, point C to point D, if an aircraft utilizing the U. S. altitude algorithm desires to descend for weapons release, he would return to his predetermined "low" altitude instantaneously. The Australian version allows the aircraft to again descend in a step fashion to his weapons release point.

After weapons release, and against a low level third world threat, most aircraft would egress the target area at high altitudes to conserve fuel and evade low altitude SAM's and AAA. An aircraft operating with the U.S. version would fly an AGL profile at his predetermined "high" altitude for his egress, while the aircraft utilizing the Australian algorithm would proceed at MSL altitudes. Figure 6 shows the differences between egress MSL and AGL altitudes.

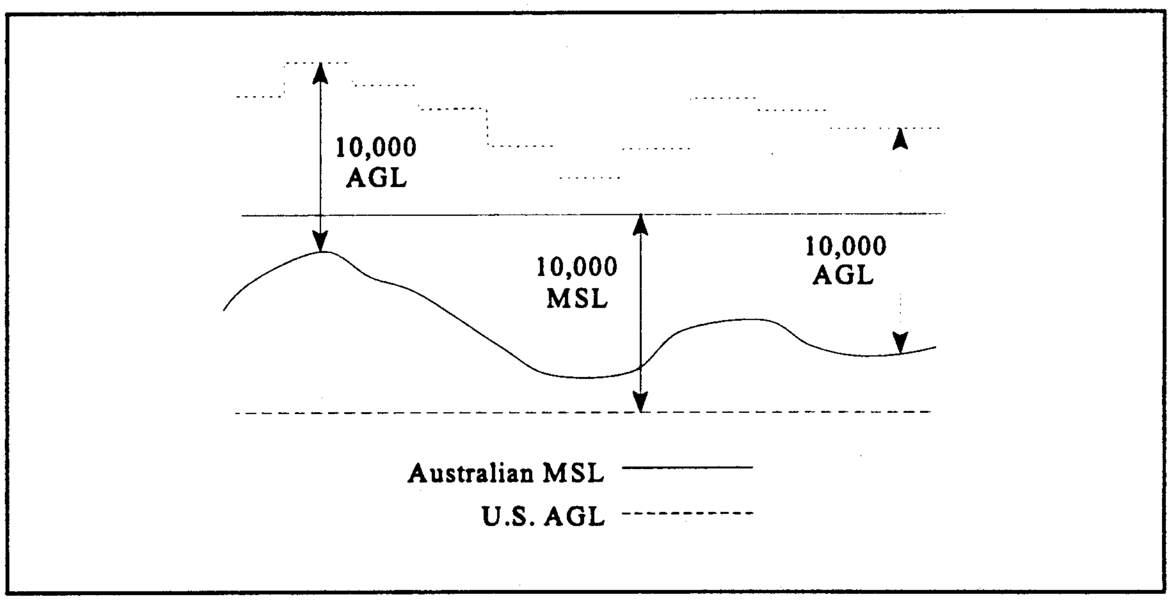

Figure 6 Differences in Egress Flight Profiles at 10,000 Feet

The U.S. algorithm is unrealistic for two reasons. First of all, above 5000 feet AGL the aircraft can not operate the radar altimeter accurately. Secondly, the aircraft would never fly this profile due to the high fuel requirements that accompany frequent variations in altitudes associated with this type of flight path. The Australian algorithm, however, would fly the exact MSL profile of the "live" aircraft during the egress sequence.

•

IV. SCENARIO DEVELOPMENT AND EXPERIMENTAL DESIGN

A. SCENARIO DEVELOPMENT

For this project, there existed two Australian terrain areas to select from. The first piece of terrain consisted of a near land environment that contained a 50 kilometer coastline in Queensland, Australia called Shoal Water Bay. This section of terrain was not selected due to the small variations in elevation across the land mass. In other words, without a varying degree of terrain elevations the differences between AGL and MSL altitude profiles would not be realized. The second piece of terrain represented an area called Lavale, also located in Queensland, Australia. This section of terrain contained significant mountainous terrain coupled with valleys that could aid in terrain masking of the inbound aircraft.

The strike scenario consists of an ingress by a simulated F-18 at 540 KIAS at 500 ft AGL. The primary anti-aircraft weapon that the simulated aircraft must counter is a simulated SA-7 missile system. Seven miles prior to target the aircraft would ascend to 15,500 ft MSL and, at two miles from the target, the aircraft would roll over, descending back to 10,500 ft MSL for weapons release. Following weapons release, the aircraft would then egress at an altitude of 10,500ft. [Ref. 7]

This strike would be carried out against a low intensity target that consisted mainly of SA-7 sites and some Soviet Bloc AAA guns. The feasibility of this tactical profile was approved by Strike University in Fallon, Nevada and verified as unclassified in nature [Ref. 7]. The anti air weaponry was implemented to collect data for this projects MOE's. The post processing files inherent in the Janus system would provide information on the number of radar detections in a weapons hold environment and information concerning destroyed or engaged aircraft in a weapons free environment. From this data, a determination of performance between the two algorithms could be realized.

Since the U.S. version was limited to two altitude selections, only the ingress altitude (500 ft AGL) and the weapons release/egress altitude (10,500 ft AGL) were utilized. The simulated aircraft flew two varying profiles using the U.S. altitude algorithm. The first profile, Profile A required the simulated aircraft to ingress at 500 ft AGL to a point two miles from the target. This point was the simulated weapons release point for all three profiles. At this point the simulated aircraft would immediately ascend to 10,500 ft AGL, and proceed at that altitude for the remainder of the Janus run. Profile B, was to ingress at 500 ft AGL to a point seven miles from the target, at that point the simulated aircraft would ascend to its final altitude of 10,500 ft AGL for the remainder of the Janus run. Finally, the simulated aircraft would fly Profile C utilizing the Australian altitude algorithm. The simulated aircraft would ingress at an altitude of 500 ft AGL to a point seven miles from the target. The simulated aircraft would then climb at a rate of 3000 ft per mile until the aircraft was two miles from the target. At that point the simulated aircraft would descend back to 10,500 ft MSL for simulated weapons release. The aircraft would then egress at this altitude for the remainder of the Janus run. Figure 7 below shows the three different strike profiles flown in this study.

B. EXPERIMENTAL DESIGN

The purpose of the experimental design was to measure tactical aircraft performance utilizing the different flight algorithms that were available. This task was accomplished by creating two scenarios that subjected the simulated aircraft to two separate threat environments. The threat environments consisted of a weapons hold status and a weapons free status. These scenarios were realistic in that they represented the type of scenario faced

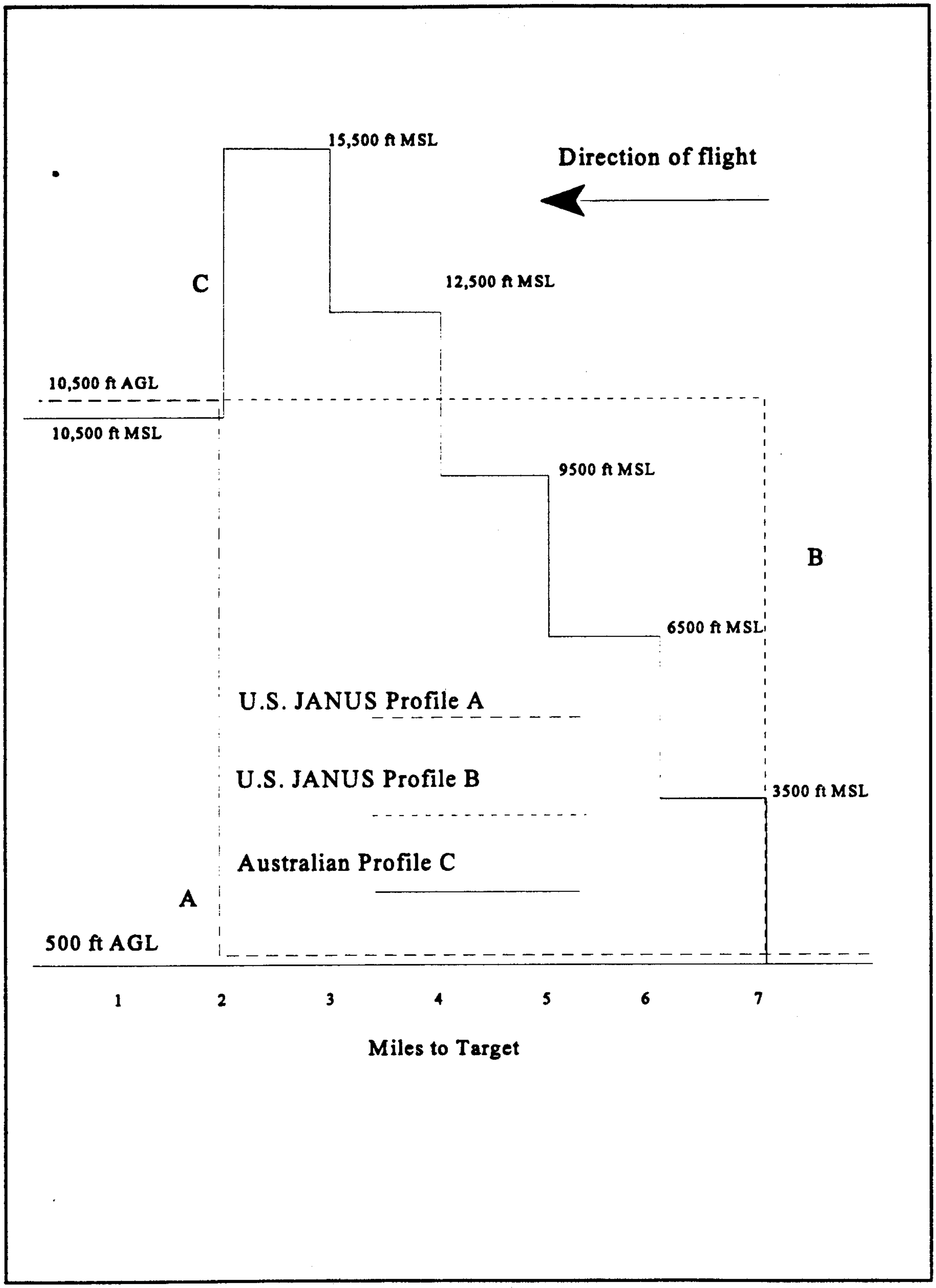

Figure 7 Simulated Strike Profiles with Differing Algorithms

by aircraft in both Desert Shield and Desert Storm operations. Both scenarios provided data on numbers of detections, enemy fires, and blue kills.

This study conducted 60 Janus runs for evaluation of algorithm performance. The first 30 runs were conducted in a weapons hold environment. Weapons hold prevented any engagements as the simulated aircraft proceeded over their individual strike routes. This weapons status was set primarily to gather detection data for each profile over the entire strike route. Once this data was collected, a one way ANOVA would be conducted to see if there was significant differences in the mean number of detections of simulated blue aircraft by red AAW and the mean number of detections of red AAW by simulated blue aircraft.

The next 30 runs were executed in a weapons free environment. This weapon status allowed for Red AAW to engage the simulated aircraft as they proceeded on both the ingress and egress portions of the strike route. Six simulated SA-7's and four simulated ZSU-23 anti-air guns were placed along the strike route. Detection and engagement data were collected utilizing Janus post-processing files. Since the data was not continuous in nature and finitely small in range (0-5 in most cases), several nonparametric techniques were utilized.

Finally, a utility based function was created to quantitatively evaluate the performance of the simulated aircraft utilizing all three profiles in the weapons free environment.

V. ANALYSIS

A. WEAPONS HOLD ENVIRONMENT

The Janus post-processor generated a file called ppdtec.dat. This file provided the number of detections by both the aircraft and AAW weapons per Janus run. A partial table of run number 1 is shown below, the remainder of the weapons hold runs are included in Appendix A.

TABLE 1 PPDET.DAT RUN 1

CLOCK	OFF. SIDE/ UNIT	OFF. STATUS	TGT SIDE/ UNIT	TGT STATUS	RANGE	SENSOR
RUN 1						
0.895933	1/2	STAT,DEF	1/1	FLY@NAP-1	3.66222024	1
1.062600	1/2	STAT,DEF	1/1	FLY@NAP-1	2.51770139	2
1.229269	1/2	STAT,DEF	1/1	FLY@NAP-1	1.45210719	3
1.620941	2/2	STAT,DEF	1/1	FLY@NAP-1	0.53543574	3
1.729276	1/2	STAT,DEF	1/1	FLY@NAP-1	2.18250751	0
1.954279	2/2	STAT,DEF	1/1	FLY@NAP-1	1.92660165	1
2.129277	2/2	STAT,DEF	1/1	FLY@NAP-1	2.68832254	0

From this table, the number of detected simulated aircraft were calculated for each of the three independent profiles. To determine if the data above could be subjected to ANOVA testing, normality checks were conducted. This analysis utilized the graphical tools inherent in the computer statistical package Minitab [Ref. 8:p. 8-3]. The following graphs were generated for each profile in the weapons hold environment. All three profiles contain ten data points that are subjected to the normality criteria. The graphs below do not show repeat values that were possible in each profile, therefore, some graphs appear to contain less than ten data points.

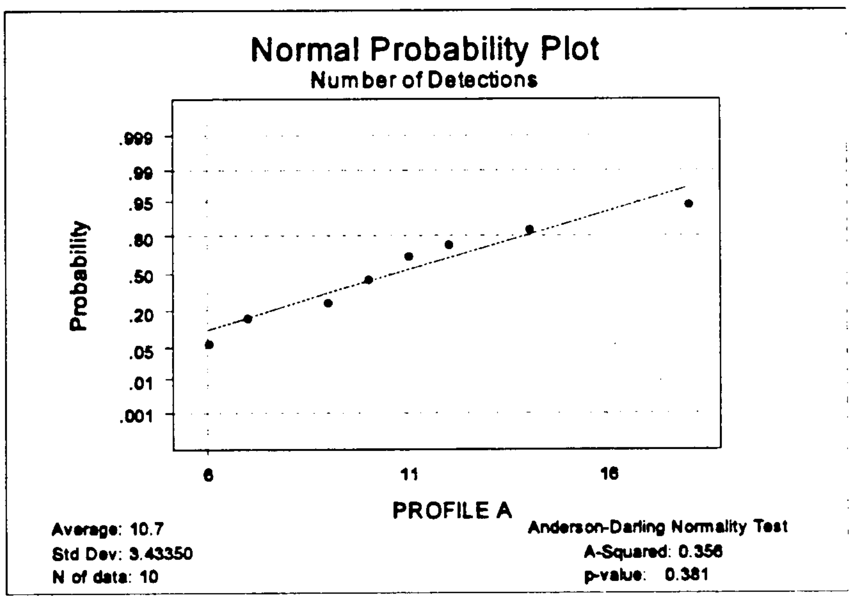

Figure 8 Normal Plot Profile A

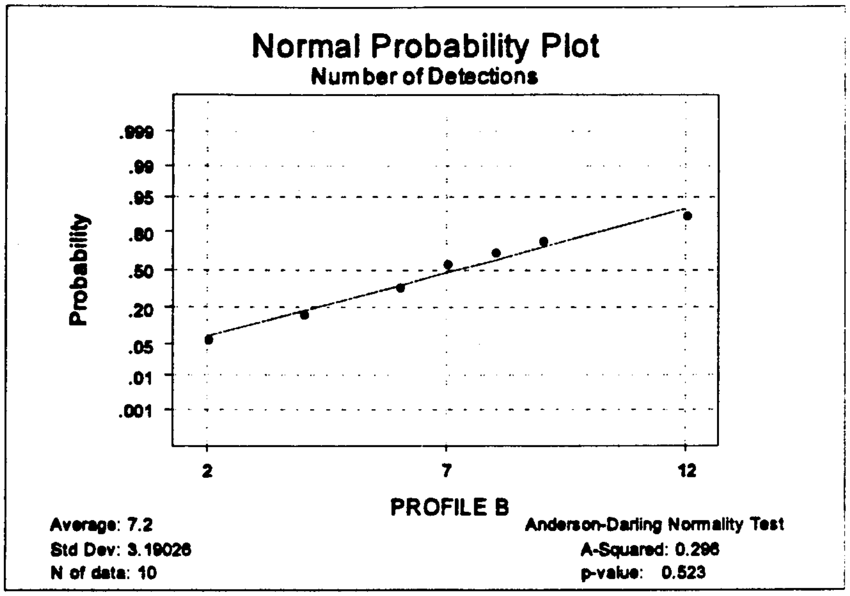

Figure 9 Normal Plot Profile B

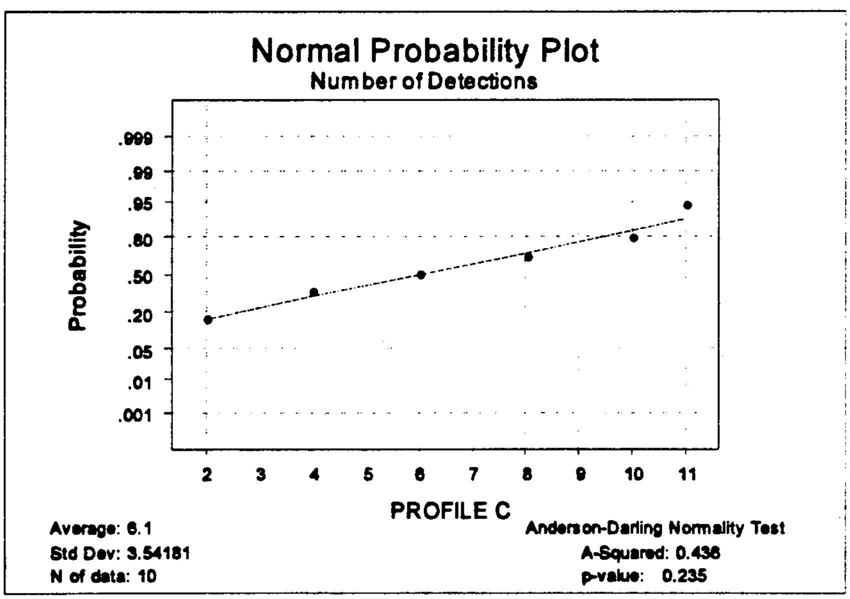

Figure 10 Normal Plot Profile C

From the three graphs above, an assumption of normality was applied for further analysis of the data. The mean number of detections per run for each profile were 10.7, 7.2, and 6.1 respectively. A one way ANOVA was then conducted utilizing the null hypothesis, $\mu1=\mu2=\mu3$. The following table shows the statistical results of that test.

The p-value of 0.014 indicates there is sufficient evidence to support a statistical

TABLE 2 ANOVA FOR MEAN DETECTIONS OF BLUE AIRCRAFT

```
                         ANALYSIS OF VARIANCE

SOURCE     DF    SS     MS    F     p

FACTOR     2     115.4  57.7  5.02  0.014
ERROR      27    310.6  11.5
TOTAL      29    426.0

                      INDIVIDUAL 95% CI'S FOR MEAN
                         BASED ON POOLED STDEV

LEVEL      N     MEAN       STDEV
                                        -----+---------+---------+---------+-
PROF A     10    10.700     3.433                      (--------*--------)
PROF B     10    7.200      3.190          (--------*--------)
PROF C     10    6.100      3.542        (-------*--------)
                                        -----+---------+---------+---------+-
POOLED STDEV =   3.392                       5.0       7.5      10.0      12.5
```

difference between the three profile means. Therefore, reject the null hypothesis that the means are all equal. [Ref. 9]

Similarly, the number of detections that the simulated aircraft had against enemy AAW sites were calculated for each profile. The same graphical tests were run and all three profiles satisfied the normality requirements. A one way ANOVA was again run utilizing the same null hypothesis. The following table indicates the results of that test.

TABLE 3 ANOVA FOR MEAN DETECTIONS OF RED AAW

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F	p
FACTOR	2	1445.6	722.8	31.70	0.000
ERROR	27	615.6	22.8		
TOTAL	29	2061.2			

INDIVIDUAL 95% CI'S FOR MEAN
BASED ON POOLED STDEV

LEVEL	N	MEAN	STDEV	
				`---------+---------+---------+-------`
PROFA	10	19.200	7.146	`                            (----*----)`
PROFB	10	4.000	2.708	`(----*----)`
PROFC	10	5.000	3.162	`  (----*----)`
				`---------+---------+---------+-------`
POOLED STDEV =	4.775			`        6.0      12.0      18.0`

The p-value again reflects that there exists a statistical difference between the three profile means exists.

Since the number of detections in Profile A was 300% higher than the number of detections in Profile B and Profile C, another one way ANOVA was conducted a third time to evaluate whether or not the mean number of detections between Profile B and Profile C were statistically significant. In both cases listed above, the analysis indicated that the null hypothesis, $\mu 1 = \mu 2$, could not be rejected. The next phase of analysis involved executing the strike scenarios in a weapons free environment.

B. WEAPONS FREE ENVIRONMENT

After the three profiles were flown in a weapons hold environment, the red AAW assets were permitted to shoot down all incoming simulated aircraft that met the engagement criteria. Janus generated two post processing files that provided the data used for this portion of the analysis, ppfirs.dat and ppkils.dat. The first file provided shot information on the inbounding blue aircraft, while the second provided actual kills on the inbounding aircraft. Appendix B and Appendix C contain the raw data for these runs.

Nonparametric techniques were used for the fires and kills data. The Mood's median test, which provides a nonparametric analysis of a one way layout, tested the null hypothesis, population medians are all equal. Mood assumes that the data are independent random samples from distributions of the same shape. [Ref. 10:p. 18-11] This assumption is realistic due to the stochastic nature of Janus and the processes involved in generating probability of hit and kill tables. This design was utilized due to the nature of the experiment. Since only two simulated F-18's were present in each run, the number of kills were limited to 0, 1, or 2. Similarly, the number of fires made by the red AAW sights were all less than four against the inbound aircraft. The table below shows the results of the test for the fires and kills respectively.

TABLE 4 MOOD MEDIAN TEST FOR KILLS PER RUN

```
                         Mood median test of kills

Chisquare = 0.37      df = 2          p = 0.830

                          Individual 95.0% CI's

profile      N<     N>=    Median      Q3-Q1+---------+---------+---------+------

  A          2      8      1.00        1.25           (-----+---------------)
  B          2      8      1.00        0.25           (-----+
  C          3      7      1.00        1.00     (----------------+
                                             +---------+---------+---------+------
                                           0.00      0.60      1.20      1.80

Overall median = 1.00
```

TABLE 5 MOOD MEDIAN TEST FOR FIRES PER RUN

```
                         Mood median test of fires

Chisquare = 0.95      df = 2          p = 0.621

                          Individual 95.0% CI's

profile N<=    N>      Median          Q3-Q1------+---------+---------+---------+

  A     8      2       2.00            1.25   (-------------+---)
  B     6      4       2.00            1.00                 +-------------)
  C     7      3       2.00            2.25   (-------------+-----------------)
                                              ------+---------+---------+---------+
                                                  1.40      2.10      2.80      3.50

Overall median = 2.00
```

The Mood's median test showed, in both cases, that the null hypothesis could not be rejected. The p-values, 0.830 and 0.621 respectively, indicate that there exist no statistical difference between the three profiles.

Another test was conducted utilizing the ppkils.dat file. The recorded time of kills were used from each profile. Since no run exceeded 5.0 minutes of simulation time, aircraft that survived the strike were assigned a time of 5.0 minutes. The Mood's median test was utilized again due to the nonparametric nature of the data. [Ref. 11]. The table below show the results of the test.

TABLE 6 MOOD'S MEDIAN TEST FOR KILL TIMES

```
                          Mood median test of TIME

Chisquare = 1.62   df = 2   p = 0.446

                            Individual 95.0% CI's

Profile N<   N>=   Median    Q3-Q1    ----------+---------+---------+------

   A     11   9     1.83      3.74    (---+-------------------------)
   B      9  11     5.00      0.69                            (-----+
   C      7  13     5.00      3.52          (----------------------+
                                      ----------+---------+---------+------
                                               2.4       3.6       4.8

Overall median = 5.00
```

The resultant p-value shows there does not exist a significant difference between the medians of the three profiles. The time that a simulated aircraft survives does not vary enough to generate a statistical difference. Even though the medians of Profile B and Profile C are 5.0 and Profile A's median is noticeably lower, 1.83, the amount of variation in Profile A accounts for the resulting failure to reject criteria.

For the final portion of the analysis, a utility function was created to reflect mission performance of each run in the weapons free environment. The mission was divided into three distinct parts; the ingress, weapons delivery at the target, and the egress. A value was assigned to each run that ranged from 0 to 3. The following table denotes the method in which the values were assigned.

TABLE 7 ASSIGNMENT OF UTILITY VALUES

X		Description
0	----	Both aircraft shotdown prior to the target.
1	----	One aircraft shotdown prior to the target, second aircraft survives to the target.
2	----	Both aircraft survive to the target, one aircraft shotdown on egress.
3	----	Both aircraft complete the mission successfully.

The utility function $U(x)=e^{x}$, was selected because completing the mission with both aircraft surviving was exponentially more important than the case where both aircraft were lost prior to weapons release.

The figure below shows how the values were distributed amongst the three profiles and their respective utility values.

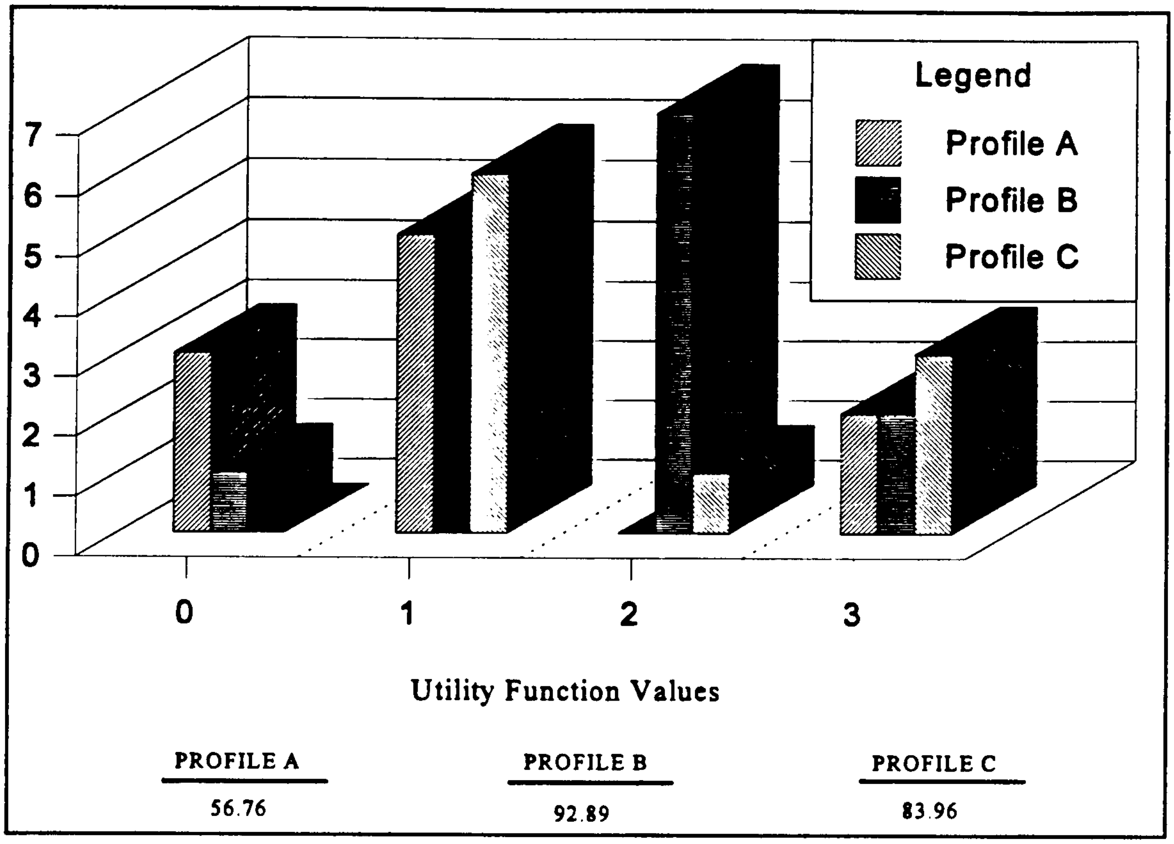

Figure 11 Utility Function Values and Distribution

The utility values make sense for each profile and directly reflect the amount of time that each simulated aircraft spent in the AAW weapons envelope. The aircraft flying Profile B was at 10,500 feet AGL early in the route out of the SA-7's range. Therefore, the number of aircraft shot down prior to the target were negligible. The aircraft flying Profile A ingressed at 500 feet AGL until 2 miles prior to the target. That aircraft was susceptible to enemy fire for a significant amount of time. Thus, the attrition rate was high prior to the target.

A Mood's median test was conducted to see if the above premise had statistical relevance. The following table reflects the results.

TABLE 8 MOOD MEDIAN TEST FOR UTILITY

```
                         Mood median test of UTILITY

Chisquare = 10.40   df = 2   p = 0.006

                              Individual 95.0% CI's

Profiles      N<=   N>    Median       Q3-Q1  -+---------+---------+---------+-----

  A            8     2     1.00        1.50     (---------+------)
  B            1     9     2.00        0.25                         +--)
  C            6     4     1.00        2.00               +------------------)
                                              -+---------+---------+---------+-----
                                              0.0       1.0       2.0       3.0
Overall median = 1.50
```

The results of the Mood's median test reject the null hypothesis. The medians of all three profiles are not equal. Two more tests were conducted to see if there existed a difference between Profiles A&B and Profiles A&C. There was not a statistical difference between Profile A and Profile C, however, there was a difference between Profile A and Profile B. The results of that test are reflected in the table below.

TABLE 9 MOOD MEDIAN TEST FOR UTILITY PROFILES A&B

```
                    Mood median test of UTIL A&B

Chisquare = 9.90   df = 1   p = 0.002

                            Individual 95.0% CI's
Prf A&B    N<    N>=   Median     Q3-Q1  -------+---------+---------+---------

   A        8     2    2.7        6.1   (-----+------------------)
   B        1     9    7.4        3.2                      +-------------)
                                         -------+---------+---------+---------
                                               3.0       6.0       9.0
Overall median = 7.4

A 95.0% C.I. for median(A) - median(B): (-6.4,-4.7)
```

The test showed that there was a difference between the utility values of Profiles A and B. The raw data reflects that the utility value of Profile B was nearly double the value of Profile A, 92.89 to 56.76 respectively. This result supports the premise made at the beginning of this section. The simulated aircraft that spends the least amount of time in the AAW weapons arena will survive longer, and thus perform the mission more successfully.

The data analysis provided a good insight to the problems inherent to the Janus simulation regarding fixed wing aircraft. The next chapter will address these issues and make further recommendations for follow-on studies.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Whenever improvements are made to a simulation that more realistically models the systems inherent to the simulation, an increase in credibility and user acceptability results. A real aircraft strike profile requires the simulated aircraft meet certain altitude windows throughout the flight (e.g. the 500 foot ingress, 15,500 roll-over point, and the 10,500 foot weapons release point). The U.S. algorithm can not accurately model aircraft strike profiles due to the two altitude restrictions. Furthermore, the inability to fly simulated aircraft at MSL altitudes limits the validity and performance of the model. Additionally, the predetermination of choosing the ingress altitude and the weapons release altitude for the U.S. runs allowed for the simulated aircraft to be exposed to the AAW weapons throughout the entire run. The simulated aircraft using the Australian algorithm not only flew a profile more closely to actual flight, but also was able to climb to the 15,500 altitude and thus evade the AAW weapons for a short time. This resultant period at 15,500 feet reflected the improved performance of the simulated aircraft.

In the case of this work, the mean number of detections against the simulated blue aircraft, flying the Australian profile, were less than the runs utilizing the U. S. algorithm. Although the remaining tests did not show significant statistical differences in flight profiles, Janus AAW algorithms appear to perform accurately. The aircraft ingressing at low altitude were being detected, engaged, and killed at a greater rate than the aircraft at high altitude. The utility analysis demonstrated this result. This performance agrees with tactical doctrine and publications regarding the red threat that was assembled.

The statistical performance of the simulated aircraft is important, however, the ability to fly at MSL altitudes in addition to AGL altitudes is equally, if not more important. Fixed wing aircraft fly at MSL altitudes more than AGL altitudes for the reasons mentioned before. Janus initially modelled helicopter effects with no original intent to model fixed wing aircraft. This is important to note because unlike fixed wing aircraft, helicopters fly more at AGL altitudes than MSL altitudes, due to their low altitude operations. In addition, by allowing the operator to control the selection of altitude and speed of the simulated aircraft, the simulation again improves in the modeling of fixed wing aircraft. Tactical evasive maneuvers can be incorporated into the simulation with the addition of operator control.

B. RECOMMENDATIONS

The altitude and speed algorithms that have been developed by the Australian Army are a great improvement over its U.S. counterpart. The Australian's have continued to improve these algorithms and expect to have an algorithm developed within the next few months that includes climb and descent rates. This improvement will allow simulated aircraft to fly an even more accurate flight profile. Further evaluation of this new algorithm could assist in the Janus Fast Mover project. The climb and descent rates are paramount for incorporation into the Fast Mover's virtual simulator project.

In a time where Joint Operations are stressed and Joint Training is needed, accurate portrayal of fixed wing aircraft in Janus is necessary. By realistically representing fixed wing aircraft in Janus, the U.S. Army will be able to practice tactics and maneuvers with both Naval and Air Force units. This training would prove invaluable for Joint Theater Warfare.

APPENDIX A. PPDETS.DAT FILE

CLOCK	OFF UNIT/ SIDE	STATUS	TGT T UNIT/ JSIDE	STATUS	RANGE	SENSOR
RUN 1						
0.895933	1/2	STAT,DEF	1/1	FLY@NAP-1	3.66222024	1
1.062600	1/2	STAT,DEF	1/1	FLY@NAP-1	2.51770139	2
1.229269	1/2	STAT,DEF	1/1	FLY@NAP-1	1.45210719	3
1.620941	2/2	STAT,DEF	1/1	FLY@NAP-1	0.53543574	3
1.729276	1/2	STAT,DEF	1/1	FLY@NAP-1	2.18250751	0
1.954279	2/2	STAT,DEF	1/1	FLY@NAP-1	1.92660165	1
2.129277	2/2	STAT,DEF	1/1	FLY@NAP-1	2.68832254	0
1.033433	1/1	FLY@NAP-1	4/2	STAT,DEF	0.51813960	1
1.200102	1/1	FLY@NAP-1	9/2	STAT,DEF	0.44791150	3
1.200102	1/1	FLY@NAP-1	4/2	STAT,DEF	0.68583381	0
1.200102	1/1	FLY@NAP-1	5/2	STAT,DEF	2.64356351	1
1.366771	1/1	FLY@NAP-1	18/2	STAT,DEF	0.37866914	3
1.366771	1/1	FLY@NAP-1	9/2	STAT,DEF	0.65596867	0
1.366771	1/1	FLY@NAP-1	14/2	STAT,DEF	0.78805488	2
1.533440	1/1	FLY@NAP-1	14/2	STAT,DEF	0.33076540	0
1.533440	1/1	FLY@NAP-1	18/2	STAT,DEF	0.93638313	0
1.533440	1/1	FLY@NAP-1	5/2	STAT,DEF	1.08748794	0
1.700109	1/1	FLY@NAP-1	16/2	STAT,DEF	0.37769851	3

1.700109	1/1	FLY@NAP-1	10/2	STAT,DEF	1.38877308	2
1.700109	1/1	FLY@NAP-1	15/2	STAT,DEF	1.43192625	3
1.700109	1/1	FLY@NAP-1	5/2	STAT,DEF	1.66588020	1
1.866778	1/1	FLY@NAP-1	15/2	STAT,DEF	0.37037200	0
1.866778	1/1	FLY@NAP-1	10/2	STAT,DEF	0.47518802	1
1.866778	1/1	FLY@NAP-1	16/2	STAT,DEF	0.78359443	0
1.866778	1/1	FLY@NAP-1	5/2	STAT,DEF	2.68131495	0
2.033445	1/1	FLY@NAP-1	10/2	STAT,DEF	0.73122007	0

RUN 2

1.070934	1/2	STAT,DEF	1/1	FLY@NAP-1	2.33104444	1
1.187602	3/2	STAT,DEF	1/1	FLY@NAP-1	0.12891315	3
1.204269	9/2	STAT,DEF	1/1	FLY@NAP-1	0.44791150	3
1.361090	3/2	STAT,DEF	1/1	FLY@NAP-1	0.93710005	0
1.377757	9/2	STAT,DEF	1/1	FLY@NAP-1	0.85001707	0
1.411091	1/2	STAT,DEF	1/1	FLY@NAP-1	0.91339123	2
1.577760	1/2	STAT,DEF	1/1	FLY@NAP-1	1.39817905	0
1.677761	5/2	STAT,DEF	1/1	FLY@NAP-1	1.51977861	2
1.844430	5/2	STAT,DEF	1/1	FLY@NAP-1	2.48134971	1
2.011098	5/2	STAT,DEF	1/1	FLY@NAP-1	3.68123937	0
2.219429	15/2	STAT,DEF	1/1	FLY@NAP-1	1.42690051	1
2.394426	15/2	STAT,DEF	1/1	FLY@NAP-1	2.46562886	0

1.041767	1/1	FLY@NAP-1	4/2	STAT,DEF	0.51813960	1
1.041767	1/1	FLY@NAP-1	5/2	STAT,DEF	3.77476382	1
1.208435	1/1	FLY@NAP-1	9/2	STAT,DEF	0.44791150	3
1.381924	1/1	FLY@NAP-1	9/2	STAT,DEF	0.85001707	0

1.381924	1/1	FLY@NAP-1	18/2	STAT,DEF	0.28974921	3
1.381924	1/1	FLY@NAP-1	14/2	STAT,DEF	0.58831549	1
1.381924	1/1	FLY@NAP-1	4/2	STAT,DEF	1.92782295	0
1.548593	1/1	FLY@NAP-1	14/2	STAT,DEF	0.52726507	0
1.548593	1/1	FLY@NAP-1	18/2	STAT,DEF	1.13618958	0
1.548593	1/1	FLY@NAP-1	5/2	STAT,DEF	1.11715841	0
1.715261	1/1	FLY@NAP-1	16/2	STAT,DEF	0.37769851	2
1.715261	1/1	FLY@NAP-1	5/2	STAT,DEF	1.66588020	1
1.715261	1/1	FLY@NAP-1	10/2	STAT,DEF	1.38877308	1
1.715261	1/1	FLY@NAP-1	15/2	STAT,DEF	1.43192625	3
1.881930	1/1	FLY@NAP-1	15/2	STAT,DEF	0.37037200	1
1.881930	1/1	FLY@NAP-1	16/2	STAT,DEF	0.78359443	0
1.881930	1/1	FLY@NAP-1	5/2	STAT,DEF	2.68131495	0
2.048598	1/1	FLY@NAP-1	15/2	STAT,DEF	0.83028376	0
2.048598	1/1	FLY@NAP-1	10/2	STAT,DEF	0.91455853	0
2.398592	1/1	FLY@NAP-1	172	STAT,DEF	1.26251197	1

RUN 3

1.587607	2/2	STAT,DEF	1/1	FLY@NAP-1	0.71064395	2
1.670942	6/2	STAT,DEF	1/1	FLY@NAP-1	2.32756019	2
1.754276	2/2	STAT,DEF	1/1	FLY@NAP-1	0.62858915	3
2.004279	6/2	STAT,DEF	1/1	FLY@NAP-1	2.00399804	0
2.095944	2/2	STAT,DEF	1/1	FLY@NAP-1	2.65003014	0
2.162610	15/2	STAT,DEF	1/1	FLY@NAP-1	1.28144443	3
2.179276	6/2	STAT,DEF	1/1	FLY@NAP-1	1.45190978	1
2.337607	15/2	STAT,DEF	1/1	FLY@NAP-1	2.28155470	0
2.354274	6/2	STAT,DEF	1/1	FLY@NAP-1	1.02788079	0

1.141768	1/1	FLY@NAP-1	5/2	STAT,DEF	3.01472020	3
1.308437	1/1	FLY@NAP-1	9/2	STAT,DEF	0.29289624	3
1.308437	1/1	FLY@NAP-1	4/2	STAT,DEF	1.32861352	1
1.308437	1/1	FLY@NAP-1	18/2	STAT,DEF	0.70867759	1
1.308437	1/1	FLY@NAP-1	1/2	STAT,DEF	1.13870621	1
1.308437	1/1	FLY@NAP-1	14/2	STAT,DEF	1.18777132	1
1.308437	1/1	FLY@NAP-1	5/2	STAT,DEF	2.06205297	0
1.475106	1/1	FLY@NAP-1	18/2	STAT,DEF	0.62088943	3
1.475106	1/1	FLY@NAP-1	14/2	STAT,DEF	0.03564876	2
1.475106	1/1	FLY@NAP-1	9/2	STAT,DEF	1.44190454	0
1.475106	1/1	FLY@NAP-1	1/2	STAT,DEF	1.04066789	0
1.475106	1/1	FLY@NAP-1	4/2	STAT,DEF	2.52737141	0
1.641775	1/1	FLY@NAP-1	14/2	STAT,DEF	1.12420487	0
1.641775	1/1	FLY@NAP-1	18/2	STAT,DEF	1.73588216	0
1.641775	1/1	FLY@NAP-1	1/2	STAT,DEF	1.68471611	1
1.641775	1/1	FLY@NAP-1	16/2	STAT,DEF	0.76973766	1
1.641775	1/1	FLY@NAP-1	10/2	STAT,DEF	1.73735011	1
1.641775	1/1	FLY@NAP-1	15/2	STAT,DEF	1.81151009	3
1.808443	1/1	FLY@NAP-1	16/2	STAT,DEF	0.38379663	3
1.808443	1/1	FLY@NAP-1	1/2	STAT,DEF	2.57648826	0
1.975112	1/1	FLY@NAP-1	15/2	STAT,DEF	0.43047553	0
1.975112	1/1	FLY@NAP-1	10/2	STAT,DEF	0.55934936	0
1.975112	1/1	FLY@NAP-1	16/2	STAT,DEF	1.58348262	0
1.975112	1/1	FLY@NAP-1	5/2	STAT,DEF	3.48123121	1
2.150110	1/1	FLY@NAP-1	5/2	STAT,DEF	4.09732056	0

RUN 4

1.170935	1/2	STAT,DEF	1/1FLY@NAP-1	1.61667299	1
1.170935	3/2	STAT,DEF	1/1FLY@NAP-1	0.12891315	3
1.337604	1/2	STAT,DEF	1/1FLY@NAP-1	0.95157981	2
1.337604	3/2	STAT,DEF	1/1FLY@NAP-1	0.93710005	0
1.504273	1/2	STAT,DEF	1/1FLY@NAP-1	1.17964137	1
1.570940	2/2	STAT,DEF	1/1FLY@NAP-1	0.71064395	3
1.670942	1/2	STAT,DEF	1/1FLY@NAP-1	2.01038456	0
1.895945	6/2	STAT,DEF	1/1FLY@NAP-1	1.94200480	1
1.904278	2/2	STAT,DEF	1/1FLY@NAP-1	1.72678399	1
2.070945	2/2	STAT,DEF	1/1FLY@NAP-1	2.65003014	0
2.237609	6/2	STAT,DEF	1/1FLY@NAP-1	1.10561025	0

1.000099	1/1	FLY@NAP-1	5/2STAT,DEF	3.77476382	2
1.166768	1/1	FLY@NAP-1	4/2STAT,DEF	0.48651868	1
1.166768	1/1	FLY@NAP-1	9/2STAT,DEF	0.63531685	3
1.333437	1/1	FLY@NAP-1	9/2STAT,DEF	0.65596867	0
1.333437	1/1	FLY@NAP-1	14/2STAT,DEF	0.78805488	1
1.333437	1/1	FLY@NAP-1	1/2STAT,DEF	0.95157981	1
1.333437	1/1	FLY@NAP-1	5/2STAT,DEF	1.72068477	0
1.333437	1/1	FLY@NAP-1	4/2STAT,DEF	1.72802913	0
1.500106	1/1	FLY@NAP-1	14/2STAT,DEF	0.33076540	0
1.500106	1/1	FLY@NAP-1	1/2STAT,DEF	1.17964137	0
1.666775	1/1	FLY@NAP-1	2/2STAT,DEF	0.30009103	3
1.666775	1/1	FLY@NAP-1	16/2STAT,DEF	0.57234120	1
1.666775	1/1	FLY@NAP-1	10/2STAT,DEF	1.55997968	1
1.666775	1/1	FLY@NAP-1	15/2STAT,DEF	1.62049031	3
1.833444	1/1	FLY@NAP-1	10/2STAT,DEF	0.63562673	3
1.833444	1/1	FLY@NAP-1	2/2STAT,DEF	1.12787235	0

1.833444	1/1	FLY@NAP-1	6/2STAT,DEF	2.06085062	1
2.000113	1/1	FLY@NAP-1	15/2STAT,DEF	0.63036662	0
2.000113	1/1	FLY@NAP-1	10/2STAT,DEF	0.73122007	0
2.000113	1/1	FLY@NAP-1	16/2STAT,DEF	1.78349161	0
2.000113	1/1	FLY@NAP-1	6/2STAT,DEF	2.00399804	0
2.175110	1/1	FLY@NAP-1	10/2STAT,DEF	1.14432120	1
2.350107	1/1	FLY@NAP-1	10/2STAT,DEF	2.03618383	0

RUN 5

1.129268	3/2	STAT,DEF	1/1	FLY@NAP-1	0.71126395	3
1.304270	5/2	STAT,DEF	1/1	FLY@NAP-1	2.06205297	1
1.462605	3/2	STAT,DEF	1/1	FLY@NAP-1	1.53584659	0
1.470939	5/2	STAT,DEF	1/1	FLY@NAP-1	1.27421784	2
1.495939	1/2	STAT,DEF	1/1	FLY@NAP-1	1.04066789	3
1.804277	5/2	STAT,DEF	1/1	FLY@NAP-1	2.08143044	1
1.829277	1/2	STAT,DEF	1/1	FLY@NAP-1	2.57648826	0
1.862611	10/2	STAT,DEF	1/1	FLY@NAP-1	0.63562673	3
1.970946	5/2	STAT,DEF	1/1	FLY@NAP-1	3.28125811	0
2.029279	10/2	STAT,DEF	1/1	FLY@NAP-1	0.73122007	0
2.137610	15/2	STAT,DEF	1/1	FLY@NAP-1	1.04598844	1
2.204276	10/2	STAT,DEF	1/1	FLY@NAP-1	1.14432120	1
2.312608	15/2	STAT,DEF	1/1	FLY@NAP-1	1.92295837	0
2.379273	10/2	STAT,DEF	1/1	FLY@NAP-1	2.03618383	0

1.775110	1/1	FLY@NAP-1	16/2	STAT,DEF	0.11326742	1
1.775110	1/1	FLY@NAP-1	6/2	STAT,DEF	2.22897577	2
1.941779	1/1	FLY@NAP-1	2/2	STAT,DEF	1.72678399	2

1.941779	1/1	FLY@NAP-1	15/2	STAT,DEF	0.03537986	1
1.941779	1/1	FLY@NAP-1	10/2	STAT,DEF	0.33065200	3
2.116777	1/1	FLY@NAP-1	15/2	STAT,DEF	0.96955895	0
2.116777	1/1	FLY@NAP-1	10/2	STAT,DEF	0.98531383	0
2.116777	1/1	FLY@NAP-1	16/2	STAT,DEF	2.11695242	0
2.116777	1/1	FLY@NAP-1	2/2	STAT,DEF	2.65003014	0
2.116777	1/1	FLY@NAP-1	172	STAT,DEF	1.34439170	1
2.291775	1/1	FLY@NAP-1	6/2	STAT,DEF	1.10561025	0

RUN 6

1.654275	2/2	STAT,DEF	1/1	FLY@NAP-1	0.38519007	3
1.804277	5/2	STAT,DEF	1/1	FLY@NAP-1	2.28138804	1
1.970946	5/2	STAT,DEF	1/1	FLY@NAP-1	3.28125811	0
1.987612	2/2	STAT,DEF	1/1	FLY@NAP-1	2.12642074	0
2.129277	15/2	STAT,DEF	1/1	FLY@NAP-1	1.04598844	1
2.304275	15/2	STAT,DEF	1/1	FLY@NAP-1	1.92295837	0

0.775099	1/1	FLY@NAP-1	1/2	STAT,DEF	4.44910765	1
0.950099	1/1	FLY@NAP-1	1/2	STAT,DEF	3.27117705	0
1.116768	1/1	FLY@NAP-1	3/2	STAT,DEF	0.71126395	1
1.116768	1/1	FLY@NAP-1	5/2	STAT,DEF	3.20290542	1
1.283436	1/1	FLY@NAP-1	3/2	STAT,DEF	0.34251940	3
1.283436	1/1	FLY@NAP-1	9/2	STAT,DEF	0.18306556	3
1.283436	1/1	FLY@NAP-1	5/2	STAT,DEF	2.24002504	0
1.450105	1/1	FLY@NAP-1	18/2	STAT,DEF	0.45276147	3
1.450105	1/1	FLY@NAP-1	14/2	STAT,DEF	0.19036761	2
1.450105	1/1	FLY@NAP-1	1/2	STAT,DEF	0.95847392	1
1.450105	1/1	FLY@NAP-1	9/2	STAT,DEF	1.24374771	0

1.450105	1/1	FLY@NAP-1	3/2	STAT,DEF	1.53584659	0
1.616774	1/1	FLY@NAP-1	14/2	STAT,DEF	0.92478311	0
1.616774	1/1	FLY@NAP-1	18/2	STAT,DEF	1.53595698	0
1.616774	1/1	FLY@NAP-1	1/2	STAT,DEF	1.53511715	0
1.616774	1/1	FLY@NAP-1	15/2	STAT,DEF	2.00428319	3
1.783443	1/1	FLY@NAP-1	16/2	STAT,DEF	0.18417618	3
1.783443	1/1	FLY@NAP-1	15/2	STAT,DEF	0.97003454	1
1.783443	1/1	FLY@NAP-1	10/2	STAT,DEF	1.00020945	3
1.783443	1/1	FLY@NAP-1	6/2	STAT,DEF	2.22804666	1
1.950112	1/1	FLY@NAP-1	15/2	STAT,DEF	0.23084345	0
1.950112	1/1	FLY@NAP-1	10/2	STAT,DEF	0.41367361	1
1.950112	1/1	FLY@NAP-1	16/2	STAT,DEF	1.38350999	0
1.950112	1/1	FLY@NAP-1	6/2	STAT,DEF	1.94241762	0
2.300108	1/1	FLY@NAP-1	10/2	STAT,DEF	1.69723141	0

RUN 7

1.404271	5/2	STAT,DEF	1/1	FLY@NAP-1	1.41045237	3
1.437605	1/2	STAT,DEF	1/1	FLY@NAP-1	0.95847392	3
1.645941	10/2	STAT,DEF	1/1	FLY@NAP-1	1.73735011	1
1.770943	1/2	STAT,DEF	1/1	FLY@NAP-1	2.45973301	0
1.870944	2/2	STAT,DEF	1/1	FLY@NAP-1	1.32740510	1
1.904278	6/2	STAT,DEF	1/1	FLY@NAP-1	1.96213388	1
1.979279	10/2	STAT,DEF	1/1	FLY@NAP-1	0.55934936	0
2.037612	2/2	STAT,DEF	1/1	FLY@NAP-1	2.52617335	0
2.070945	5/2	STAT,DEF	1/1	FLY@NAP-1	4.01054096	0
2.245942	6/2	STAT,DEF	1/1	FLY@NAP-1	1.10561025	0

1.041767	1/1	FLY@NAP-1	4/2	STAT,DEF	0.31953219	3
1.041767	1/1	FLY@NAP-1	5/2	STAT,DEF	3.58312082	1
1.208435	1/1	FLY@NAP-1	3/2	STAT,DEF	0.12891315	3
1.208435	1/1	FLY@NAP-1	4/2	STAT,DEF	0.68583381	1
1.208435	1/1	FLY@NAP-1	9/2	STAT,DEF	0.44791150	1
1.208435	1/1	FLY@NAP-1	5/2	STAT,DEF	2.64356351	0
1.375104	1/1	FLY@NAP-1	18/2	STAT,DEF	0.28974921	3
1.375104	1/1	FLY@NAP-1	9/2	STAT,DEF	0.85001707	0
1.375104	1/1	FLY@NAP-1	3/2	STAT,DEF	1.13654721	0
1.541773	1/1	FLY@NAP-1	18/2	STAT,DEF	1.13618958	0
1.541773	1/1	FLY@NAP-1	4/2	STAT,DEF	3.03887272	0
1.708442	1/1	FLY@NAP-1	2/2	STAT,DEF	0.33427715	2
1.708442	1/1	FLY@NAP-1	16/2	STAT,DEF	0.37769851	3
1.708442	1/1	FLY@NAP-1	5/2	STAT,DEF	1.66588020	1
1.708442	1/1	FLY@NAP-1	10/2	STAT,DEF	1.38877308	2
1.708442	1/1	FLY@NAP-1	15/2	STAT,DEF	1.43192625	3
1.875111	1/1	FLY@NAP-1	15/2	STAT,DEF	0.37037200	0
1.875111	1/1	FLY@NAP-1	16/2	STAT,DEF	0.78359443	1
1.875111	1/1	FLY@NAP-1	10/2	STAT,DEF	0.47518802	1
1.875111	1/1	FLY@NAP-1	2/2	STAT,DEF	1.32740510	0
1.875111	1/1	FLY@NAP-1	5/2	STAT,DEF	2.68131495	0
2.041779	1/1	FLY@NAP-1	10/2	STAT,DEF	0.91455853	0
2.041779	1/1	FLY@NAP-1	16/2	STAT,DEF	1.98346877	0
2.216776	1/1	FLY@NAP-1	17/2	STAT,DEF	0.87300295	1

RUN 8

1.270936	3/2	STAT,DEF	1/1	FLY@NAP-1	0.53939587	3
1.437605	1/2	STAT,DEF	1/1	FLY@NAP-1	0.95847392	3

1.437605	3/2	STAT,DEF	1/1	FLY@NAP-1	1.53584659	0
1.437605	5/2	STAT,DEF	1/1	FLY@NAP-1	1.27421784	2
1.604274	1/2	STAT,DEF	1/1	FLY@NAP-1	1.53511715	1
1.679275	10/2	STAT,DEF	1/1	FLY@NAP-1	1.38877308	3
1.770943	1/2	STAT,DEF	1/1	FLY@NAP-1	2.45973301	0
1.770943	5/2	STAT,DEF	1/1	FLY@NAP-1	2.08143044	1
1.937612	5/2	STAT,DEF	1/1	FLY@NAP-1	3.28125811	0
2.012612	10/2	STAT,DEF	1/1	FLY@NAP-1	0.91455853	0

1.016766	1/1	FLY@NAP-1	4/2	STAT,DEF	0.51813960	1
1.016766	1/1	FLY@NAP-1	5/2	STAT,DEF	3.77476382	2
1.183435	1/1	FLY@NAP-1	9/2	STAT,DEF	0.44791150	1
1.183435	1/1	FLY@NAP-1	5/2	STAT,DEF	2.64356351	0
1.350104	1/1	FLY@NAP-1	9/2	STAT,DEF	0.65596867	0
1.350104	1/1	FLY@NAP-1	18/2	STAT,DEF	0.37866914	1
1.350104	1/1	FLY@NAP-1	1/2	STAT,DEF	0.95157981	1
1.350104	1/1	FLY@NAP-1	14/2	STAT,DEF	0.78805488	1
1.350104	1/1	FLY@NAP-1	4/2	STAT,DEF	1.72802913	0
1.516773	1/1	FLY@NAP-1	14/2	STAT,DEF	0.33076540	0
1.516773	1/1	FLY@NAP-1	18/2	STAT,DEF	0.93638313	0
1.516773	1/1	FLY@NAP-1	1/2	STAT,DEF	1.17964137	0
1.683442	1/1	FLY@NAP-1	2/2	STAT,DEF	0.33427715	1
1.683442	1/1	FLY@NAP-1	16/2	STAT,DEF	0.37769851	1
1.683442	1/1	FLY@NAP-1	5/2	STAT,DEF	1.66588020	1
1.683442	1/1	FLY@NAP-1	10/2	STAT,DEF	1.38877308	1
1.683442	1/1	FLY@NAP-1	15/2	STAT,DEF	1.43192625	3
1.850111	1/1	FLY@NAP-1	16/2	STAT,DEF	0.78359443	2
1.850111	1/1	FLY@NAP-1	2/2	STAT,DEF	1.32740510	0

1.850111	1/1	FLY@NAP-1	15/2	STAT,DEF	0.37037200	1
1.850111	1/1	FLY@NAP-1	10/2	STAT,DEF	0.47518802	3
1.850111	1/1	FLY@NAP-1	5/2	STAT,DEF	2.68131495	0
2.016779	1/1	FLY@NAP-1	15/2	STAT,DEF	0.83028376	0
2.016779	1/1	FLY@NAP-1	10/2	STAT,DEF	0.91455853	0
2.016779	1/1	FLY@NAP-1	16/2	STAT,DEF	1.98346877	0
2.191776	1/1	FLY@NAP-1	15/2	STAT,DEF	1.42690051	1
2.366774	1/1	FLY@NAP-1	15/2	STAT,DEF	2.46562886	0

RUN 9

1.054267	4/2	STAT,DEF	1/1	FLY@NAP-1	0.31953219	3
1.495939	1/2	STAT,DEF	1/1	FLY@NAP-1	1.04066789	2
1.554273	4/2	STAT,DEF	1/1	FLY@NAP-1	3.03887272	0
1.637608	2/2	STAT,DEF	1/1	FLY@NAP-1	0.53543574	3
1.662608	1/2	STAT,DEF	1/1	FLY@NAP-1	1.68471611	1
1.770943	16/2	STAT,DEF	1/1	FLY@NAP-1	0.11326742	3
1.829277	1/2	STAT,DEF	1/1	FLY@NAP-1	2.57648826	0
1.937612	16/2	STAT,DEF	1/1	FLY@NAP-1	1.18350768	0
1.970946	2/2	STAT,DEF	1/1	FLY@NAP-1	1.92660165	1
2.145944	2/2	STAT,DEF	1/1	FLY@NAP-1	2.68832254	0

1.900111	1/1	FLY@NAP-1	16/2	STAT,DEF	0.98354548	1
1.900111	1/1	FLY@NAP-1	10/2	STAT,DEF	0.35717431	2
1.900111	1/1	FLY@NAP-1	6/2	STAT,DEF	1.96213388	1
2.066778	1/1	FLY@NAP-1	10/2	STAT,DEF	0.91455853	0
2.066778	1/1	FLY@NAP-1	16/2	STAT,DEF	1.98346877	0
2.066778	1/1	FLY@NAP-1	6/2	STAT,DEF	2.06334639	0

RUN 10

1.070934	1/2	STAT,DEF	1/1	FLY@NAP-1	2.51770139	1
1.095934	5/2	STAT,DEF	1/1	FLY@NAP-1	3.39244366	1
1.154268	4/2	STAT,DEF	1/1	FLY@NAP-1	0.28816646	3
1.170935	3/2	STAT,DEF	1/1	FLY@NAP-1	0.31575960	3
1.262603	5/2	STAT,DEF	1/1	FLY@NAP-1	2.24002504	0
1.279270	9/2	STAT,DEF	1/1	FLY@NAP-1	0.18306556	3
1.429272	5/2	STAT,DEF	1/1	FLY@NAP-1	1.41045237	3
1.445939	9/2	STAT,DEF	1/1	FLY@NAP-1	1.24374771	0
1.487606	4/2	STAT,DEF	1/1	FLY@NAP-1	2.52737141	0
1.504273	3/2	STAT,DEF	1/1	FLY@NAP-1	1.86327207	0
1.629274	6/2	STAT,DEF	1/1	FLY@NAP-1	2.47326159	1
1.737609	1/2	STAT,DEF	1/1	FLY@NAP-1	2.18250751	0
1.820944	10/2	STAT,DEF	1/1	FLY@NAP-1	0.81377298	3
1.929278	5/2	STAT,DEF	1/1	FLY@NAP-1	3.08125257	1
1.962612	6/2	STAT,DEF	1/1	FLY@NAP-1	1.94241762	0
1.987612	10/2	STAT,DEF	1/1	FLY@NAP-1	0.55934936	1
2.104278	5/2	STAT,DEF	1/1	FLY@NAP-1	4.01054096	0
2.337607	10/2	STAT,DEF	1/1	FLY@NAP-1	1.86368692	0

1.491773	1/1	FLY@NAP-1	18/2	STAT,DEF	0.62088943	3
1.491773	1/1	FLY@NAP-1	5/2	STAT,DEF	1.15668595	1
1.658441	1/1	FLY@NAP-1	18/2	STAT,DEF	1.73588216	0
1.825110	1/1	FLY@NAP-1	2/2	STAT,DEF	0.92853397	1
1.825110	1/1	FLY@NAP-1	16/2	STAT,DEF	0.38379663	2
1.825110	1/1	FLY@NAP-1	10/2	STAT,DEF	0.81377298	2
1.825110	1/1	FLY@NAP-1	15/2	STAT,DEF	0.77009672	3

1.825110	1/1	FLY@NAP-1	5/2	STAT,DEF	2.28138804	0
1.991779	1/1	FLY@NAP-1	15/2	STAT,DEF	0.43047553	0
1.991779	1/1	FLY@NAP-1	10/2	STAT,DEF	0.55934936	0
1.991779	1/1	FLY@NAP-1	16/2	STAT,DEF	1.58348262	0
1.991779	1/1	FLY@NAP-1	2/2	STAT,DEF	2.12642074	0

RUN 11

1.620941	10/2	STAT,DEF	1/1	FLY@NAP-1	1.91917634	1
1.737609	2/2	STAT,DEF	1/1	FLY@NAP-1	0.46198604	1
2.070945	2/2	STAT,DEF	1/1	FLY@NAP-1	2.62645006	0
2.304275	10/2	STAT,DEF	1/1	FLY@NAP-1	1.69723141	0

1.433438	1/1	FLY@NAP-1	18/2	STAT,DEF	0.32323921	1
1.600107	1/1	FLY@NAP-1	18/2	STAT,DEF	1.33605528	0
1.933445	1/1	FLY@NAP-1	10/2	STAT,DEF	0.33065200	1
2.283442	1/1	FLY@NAP-1	10/2	STAT,DEF	1.53877926	0

RUN 12

1.120934	4/2	STAT,DEF	1/1	FLY@NAP-1	0.09688376	1
1.454272	4/2	STAT,DEF	1/1	FLY@NAP-1	2.32749724	0
2.087611	10/2	STAT,DEF	1/1	FLY@NAP-1	0.98531383	1
2.145944	15/2	STAT,DEF	1/1	FLY@NAP-1	1.15244794	3
2.262609	10/2	STAT,DEF	1/1	FLY@NAP-1	1.53877926	0
2.320941	15/2	STAT,DEF	1/1	FLY@NAP-1	2.10039043	0

0.850099	1/1	FLY@NAP-1	1/2	STAT,DEF	3.85843611	1

1.016766	1/1	FLY@NAP-1	1/2	STAT,DEF	2.70626664	0
1.350104	1/1	FLY@NAP-1	18/2	STAT,DEF	0.37866914	1
1.516773	1/1	FLY@NAP-1	18/2	STAT,DEF	0.93638313	0
2.191776	1/1	FLY@NAP-1	6/2	STAT,DEF	1.45190978	1
2.366774	1/1	FLY@NAP-1	6/2	STAT,DEF	1.02788079	0

RUN 13

1.162601	9/2	STAT,DEF	1/1	FLY@NAP-1	0.63531685	1
1.329270	9/2	STAT,DEF	1/1	FLY@NAP-1	0.46696639	0
1.362604	4/2	STAT,DEF	1/1	FLY@NAP-1	1.92782295	1
1.529273	4/2	STAT,DEF	1/1	FLY@NAP-1	3.03887272	0
1.670942	2/2	STAT,DEF	1/1	FLY@NAP-1	0.30009103	2
1.837610	2/2	STAT,DEF	1/1	FLY@NAP-1	1.12787235	1
2.004279	2/2	STAT,DEF	1/1	FLY@NAP-1	2.32630444	0
2.112611	6/2	STAT,DEF	1/1	FLY@NAP-1	1.76022851	1
2.287608	6/2	STAT,DEF	1/1	FLY@NAP-1	1.04264772	0

1.291770	1/1	FLY@NAP-1	9/2	STAT,DEF	0.29289624	1
1.458439	1/1	FLY@NAP-1	9/2	STAT,DEF	1.44190454	0
1.791777	1/1	FLY@NAP-1	16/2	STAT,DEF	0.38379663	1
1.791777	1/1	FLY@NAP-1	10/2	STAT,DEF	0.81377298	1
1.958445	1/1	FLY@NAP-1	16/2	STAT,DEF	1.38350999	0
2.308441	1/1	FLY@NAP-1	10/2	STAT,DEF	1.86368692	0

RUN 14

1.162601	9/2	STAT,DEF	1/1	FLY@NAP-1	0.63531685	1
1.229269	3/2	STAT,DEF	1/1	FLY@NAP-1	0.11636218	1
1.329270	9/2	STAT,DEF	1/1	FLY@NAP-1	0.46696639	0
1.395938	3/2	STAT,DEF	1/1	FLY@NAP-1	1.33614826	0
1.629274	2/2	STAT,DEF	1/1	FLY@NAP-1	0.38519007	1
1.870944	6/2	STAT,DEF	1/1	FLY@NAP-1	2.00213480	1
1.962612	2/2	STAT,DEF	1/1	FLY@NAP-1	1.92660165	0

2.212609	6/2	STAT,DEF	1/1	FLY@NAP-1	1.31637299	0
2.216776	1/1	FLY@NAP-1	17/2	STAT,DEF	0.87300295	1
2.566771	1/1	FLY@NAP-1	17/2	STAT,DEF	2.47892904	0

RUN 15

1.054267	4/2	STAT,DEF	1/1	FLY@NAP-1	0.12545957	1
1.220936	4/2	STAT,DEF	1/1	FLY@NAP-1	0.88546187	0
1.387604	4/2	STAT,DEF	1/1	FLY@NAP-1	2.12764716	1
1.404271	5/2	STAT,DEF	1/1	FLY@NAP-1	1.41045237	1
1.554273	4/2	STAT,DEF	1/1	FLY@NAP-1	3.23224258	0
1.570940	5/2	STAT,DEF	1/1	FLY@NAP-1	1.18044865	0
1.737609	5/2	STAT,DEF	1/1	FLY@NAP-1	1.98646057	1
1.737609	10/2	STAT,DEF	1/1	FLY@NAP-1	1.07657301	3
1.737609	16/2	STAT,DEF	1/1	FLY@NAP-1	0.11326742	3
1.904278	5/2	STAT,DEF	1/1	FLY@NAP-1	3.08125257	0
1.904278	16/2	STAT,DEF	1/1	FLY@NAP-1	1.18350768	0
2.245942	10/2	STAT,DEF	1/1	FLY@NAP-1	1.53877926	0
0.766766	1/1	FLY@NAP-1	1/2	STAT,DEF	4.25192642	1
0.941766	1/1	FLY@NAP-1	1/2	STAT,DEF	3.07651258	0
1.275103	1/1	FLY@NAP-1	9/2	STAT,DEF	0.29289624	1
1.441772	1/1	FLY@NAP-1	18/2	STAT,DEF	0.45276147	1
1.441772	1/1	FLY@NAP-1	9/2	STAT,DEF	1.24374771	0
1.608441	1/1	FLY@NAP-1	18/2	STAT,DEF	1.53595698	0

RUN 16

1.853015	10/2	STAT,DEF	1/1	FLY@NAP-1	0.47518802	1
2.019683	10/2	STAT,DEF	1/1	FLY@NAP-1	0.91455853	0

RUN 17

1.179268	3/2	STAT,DEF	1/1	FLY@NAP-1	0.31575960	1
1.245936	9/2	STAT,DEF	1/1	FLY@NAP-1	0.27861983	1
1.412605	9/2	STAT,DEF	1/1	FLY@NAP-1	1.04629278	0
1.512606	3/2	STAT,DEF	1/1	FLY@NAP-1	1.86327207	0
1.679275	6/2	STAT,DEF	1/1	FLY@NAP-1	2.32756019	1
1.695942	2/2	STAT,DEF	1/1	FLY@NAP-1	0.33427715	1
1.895945	10/2	STAT,DEF	1/1	FLY@NAP-1	0.35717431	1
2.012612	6/2	STAT,DEF	1/1	FLY@NAP-1	2.00399804	0
2.029279	2/2	STAT,DEF	1/1	FLY@NAP-1	2.32630444	0
2.062612	10/2	STAT,DEF	1/1	FLY@NAP-1	0.91455853	0
2.187610	6/2	STAT,DEF	1/1	FLY@NAP-1	1.45190978	1
2.362607	6/2	STAT,DEF	1/1	FLY@NAP-1	1.02788079	0

1.825110	1/1	FLY@NAP-1	10/2	STAT,DEF	0.81377298	1
1.825110	1/1	FLY@NAP-1	15/2	STAT,DEF	0.77009672	1
1.991779	1/1	FLY@NAP-1	15/2	STAT,DEF	0.43047553	0
1.991779	1/1	FLY@NAP-1	10/2	STAT,DEF	0.55934936	0
2.166777	1/1	FLY@NAP-1	15/2	STAT,DEF	1.15244794	1
2.166777	1/1	FLY@NAP-1	10/2	STAT,DEF	1.05671370	1
2.341774	1/1	FLY@NAP-1	10/2	STAT,DEF	1.86368692	0
2.341774	1/1	FLY@NAP-1	15/2	STAT,DEF	2.10039043	0

RUN 18

1.629274	10/2	STAT,DEF	1/1	FLY@NAP-1	1.73735011	1
1.737609	2/2	STAT,DEF	1/1	FLY@NAP-1	0.46198604	1
1.795943	10/2	STAT,DEF	1/1	FLY@NAP-1	0.81377298	2
2.070945	2/2	STAT,DEF	1/1	FLY@NAP-1	2.65003014	0
2.170943	6/2	STAT,DEF	1/1	FLY@NAP-1	1.45190978	1
2.312608	10/2	STAT,DEF	1/1	FLY@NAP-1	1.86368692	0
2.345941	6/2	STAT,DEF	1/1	FLY@NAP-1	1.02788079	0
1.408438	1/1	FLY@NAP-1	18/2	STAT,DEF	0.32323921	1
1.575107	1/1	FLY@NAP-1	18/2	STAT,DEF	1.33605528	0

RUN 19

1.104267	3/2	STAT,DEF	1/1	FLY@NAP-1	0.71126395	1
1.179268	1/2	STAT,DEF	1/1	FLY@NAP-1	1.61667299	1
1.437605	3/2	STAT,DEF	1/1	FLY@NAP-1	1.53584659	0
1.679275	1/2	STAT,DEF	1/1	FLY@NAP-1	2.01038456	0
2.154277	6/2	STAT,DEF	1/1	FLY@NAP-1	1.45190978	1
2.329274	6/2	STAT,DEF	1/1	FLY@NAP-1	1.02788079	0

1.375104	1/1	FLY@NAP-1	18/2	STAT,DEF	0.28974921	1
1.541773	1/1	FLY@NAP-1	18/2	STAT,DEF	1.13618958	0
2.216776	1/1	FLY@NAP-1	17/2	STAT,DEF	0.83714658	1
2.391773	1/1	FLY@NAP-1	17/2	STAT,DEF	1.41862786	0

RUN 20

0.812599	1/2	STAT,DEF	1/1	FLY@NAP-1	3.85843611	1
0.987599	1/2	STAT,DEF	1/1	FLY@NAP-1	2.70626664	0
1.154268	1/2	STAT,DEF	1/1	FLY@NAP-1	1.78847849	1
1.487606	1/2	STAT,DEF	1/1	FLY@NAP-1	1.17964137	0
1.862611	10/2	STAT,DEF	1/1	FLY@NAP-1	0.35717431	1
2.029279	10/2	STAT,DEF	1/1	FLY@NAP-1	0.91455853	0

2.483438	1/1	FLY@NAP-1	17/2	STAT,DEF	1.88235307	1

RUN 21

1.237602	3/2	STAT,DEF	1/1	FLY@MSL	0.11636218	1

1.404271	3/2	STAT,DEF	1/1	FLY@MSL	1.13654721	0
1.350104	1/1	FLY@MSL	18/2	STAT,DEF	0.53181142	1
1.516773	1/1	FLY@MSL	18/2	STAT,DEF	0.73668391	0
1.683442	1/1	FLY@MSL	10/2	STAT,DEF	1.55997968	1
2.016779	1/1	FLY@MSL	10/2	STAT,DEF	0.73122007	0

RUN 22

1.079267	4/2	STAT,DEF	1/1	FLY@MSL	0.12545957	1
1.245936	4/2	STAT,DEF	1/1	FLY@MSL	0.88546187	0
1.408438	1/1	FLY@MSL	18/2	STAT,DEF	0.32323921	1
1.575107	1/1	FLY@MSL	18/2	STAT,DEF	1.33605528	0
1.741776	1/1	FLY@MSL	10/2	STAT,DEF	1.22631502	1
1.908445	1/1	FLY@MSL	10/2	STAT,DEF	0.35717431	0

RUN 23

1.037600	4/2	STAT,DEF	1/1	FLY@MSL	0.31953219	2
1.137601	1/2	STAT,DEF	1/1	FLY@MSL	1.96562612	1
1.195935	9/2	STAT,DEF	1/1	FLY@MSL	0.44791150	1
1.204269	4/2	STAT,DEF	1/1	FLY@MSL	0.68583381	1
1.370803	9/2	STAT,DEF	1/1	FLY@MSL	0.85001707	0
1.420804	5/2	STAT,DEF	1/1	FLY@MSL	1.41045237	1
1.545806	4/2	STAT,DEF	1/1	FLY@MSL	3.03887272	0
1.587473	5/2	STAT,DEF	1/1	FLY@MSL	1.18044865	0
1.645807	1/2	STAT,DEF	1/1	FLY@MSL	1.68471611	0

1.745808	2/2	STAT,DEF	1/1	FLY@MSL	0.62858915	1
1.912477	2/2	STAT,DEF	1/1	FLY@MSL	1.72678399	0

1.241769	1/1	FLY@MSL	9/2	STAT,DEF	0.27861983	1
1.416637	1/1	FLY@MSL	18/2	STAT,DEF	0.32323921	1
1.416637	1/1	FLY@MSL	9/2	STAT,DEF	1.04629278	0
1.583306	1/1	FLY@MSL	18/2	STAT,DEF	1.33605528	0
1.749975	1/1	FLY@MSL	10/2	STAT,DEF	1.07657301	1
1.916644	1/1	FLY@MSL	10/2	STAT,DEF	0.33065200	0

RUN 24

1.745943	2/2	STAT,DEF	1/1	FLY@MSL	0.62858915	1
1.762609	10/2	STAT,DEF	1/1	FLY@MSL	1.00020945	1
1.912611	2/2	STAT,DEF	1/1	FLY@MSL	1.72678399	0
1.929278	10/2	STAT,DEF	1/1	FLY@MSL	0.41367361	0
2.104278	10/2	STAT,DEF	1/1	FLY@MSL	1.00187075	1
2.279275	10/2	STAT,DEF	1/1	FLY@MSL	1.69723141	0

1.000099	1/1	FLY@MSL	1/2	STAT,DEF	2.70626664	1
1.166768	1/1	FLY@MSL	9/2	STAT,DEF	0.63531685	1
1.166768	1/1	FLY@MSL	1/2	STAT,DEF	1.78847849	0
1.333437	1/1	FLY@MSL	9/2	STAT,DEF	0.65596867	0
1.333437	1/1	FLY@MSL	5/2	STAT,DEF	1.72068477	1
1.500106	1/1	FLY@MSL	5/2	STAT,DEF	1.08748794	0

RUN 25

1.154268	1/2	STAT,DEF	1/1	FLY@MSL	1.96562612	1
1.262603	9/2	STAT,DEF	1/1	FLY@MSL	0.24742307	1
1.320937	1/2	STAT,DEF	1/1	FLY@MSL	1.13870621	2
1.429272	9/2	STAT,DEF	1/1	FLY@MSL	1.04629278	0
1.487606	1/2	STAT,DEF	1/1	FLY@MSL	1.04066789	1
1.654275	5/2	STAT,DEF	1/1	FLY@MSL	1.38719177	1
1.820944	1/2	STAT,DEF	1/1	FLY@MSL	2.57648826	0
1.820944	5/2	STAT,DEF	1/1	FLY@MSL	2.28138804	0
2.195943	15/2	STAT,DEF	1/1	FLY@MSL	1.28144443	1
2.370940	15/2	STAT,DEF	1/1	FLY@MSL	2.28155470	0

0.833433	1/1	FLY@NAP-1	1/2	STAT,DEF	4.05502176	1
1.008433	1/1	FLY@MSL	5/2	STAT,DEF	3.96723270	1
1.175102	1/1	FLY@MSL	3/2	STAT,DEF	0.51263702	1
1.175102	1/1	FLY@MSL	1/2	STAT,DEF	1.96562612	0
1.175102	1/1	FLY@MSL	5/2	STAT,DEF	3.01472020	0
1.341771	1/1	FLY@MSL	3/2	STAT,DEF	0.73794717	0
1.341771	1/1	FLY@MSL	18/2	STAT,DEF	0.53181142	2
1.508439	1/1	FLY@MSL	18/2	STAT,DEF	0.62088943	0
2.183443	1/1	FLY@MSL	10/2	STAT,DEF	1.14432120	1
2.358440	1/1	FLY@MSL	10/2	STAT,DEF	1.86368692	0
2.533438	1/1	FLY@MSL	17/2	STAT,DEF	2.08099842	1
2.708435	1/1	FLY@MSL	17/2	STAT,DEF	3.27626109	0

RUN 26

1.262603	3/2	STAT,DEF	1/1	FLY@MSL	0.34251940	1
1.429272	3/2	STAT,DEF	1/1	FLY@MSL	1.33614826	0

2.187610	15/2	STAT,DEF	1/1	FLY@MSL	1.28144443	1
2.362607	15/2	STAT,DEF	1/1	FLY@MSL	2.28155470	0

2.216776	1/1	FLY@MSL	17/2	STAT,DEF	0.87300295	1
2.391773	1/1	FLY@MSL	17/2	STAT,DEF	1.26251197	0

RUN 27

1.062600	1/2	STAT,DEF	1/1	FLY@MSL	2.51770139	1
1.245936	9/2	STAT,DEF	1/1	FLY@MSL	0.24742307	1
1.412605	9/2	STAT,DEF	1/1	FLY@MSL	1.04629278	0
1.562607	1/2	STAT,DEF	1/1	FLY@MSL	1.27797782	0
1.720942	10/2	STAT,DEF	1/1	FLY@MSL	1.22631502	1
1.887611	10/2	STAT,DEF	1/1	FLY@MSL	0.35717431	0
2.145944	15/2	STAT,DEF	1/1	FLY@MSL	1.15244794	1
2.320941	15/2	STAT,DEF	1/1	FLY@MSL	2.10039043	0

1.250103	1/1	FLY@MSL	9/2	STAT,DEF	0.24742307	1
1.416772	1/1	FLY@MSL	18/2	STAT,DEF	0.32323921	2
1.416772	1/1	FLY@MSL	14/2	STAT,DEF	0.38882807	1
1.416772	1/1	FLY@MSL	9/2	STAT,DEF	1.04629278	0
1.583440	1/1	FLY@MSL	14/2	STAT,DEF	0.72568208	0
1.583440	1/1	FLY@MSL	18/2	STAT,DEF	1.33605528	0
2.091778	1/1	FLY@MSL	10/2	STAT,DEF	0.98531383	1
2.266775	1/1	FLY@MSL	10/2	STAT,DEF	1.53877926	0

RUN 28

1.170935	5/2	STAT,DEF	1/1	FLY@MSL	2.82815814	1
1.504273	5/2	STAT,DEF	1/1	FLY@MSL	1.08748794	0
1.670942	5/2	STAT,DEF	1/1	FLY@MSL	1.51977861	1
1.837610	5/2	STAT,DEF	1/1	FLY@MSL	2.68131495	0
2.104278	15/2	STAT,DEF	1/1	FLY@MSL	1.04598844	1
2.279275	15/2	STAT,DEF	1/1	FLY@MSL	1.92295837	0
1.375104	1/1	FLY@MSL	14/2	STAT,DEF	0.58831549	1
1.541773	1/1	FLY@MSL	14/2	STAT,DEF	0.52726507	0

RUN 29

1.279270	9/2	STAT,DEF	1/1	FLY@MSL	0.29289624	1
1.445939	9/2	STAT,DEF	1/1	FLY@MSL	1.44190454	0

2.200109	1/1	FLY@MSL	17/2	STAT,DEF	0.87300295	1
2.725101	1/1	FLY@MSL	17/2	STAT,DEF	3.67534351	0

RUN 30

1.162601	4/2	STAT,DEF	1/1	FLY@MSL	0.28816646	1
1.295937	9/2	STAT,DEF	1/1	FLY@MSL	0.29289624	1
1.337604	3/2	STAT,DEF	1/1	FLY@MSL	0.73794717	1
1.462605	9/2	STAT,DEF	1/1	FLY@MSL	1.24374771	0
1.495939	4/2	STAT,DEF	1/1	FLY@MSL	2.52737141	0
1.504273	3/2	STAT,DEF	1/1	FLY@MSL	1.86327207	0
1.762609	16/2	STAT,DEF	1/1	FLY@MSL	0.11326742	1
1.929278	16/2	STAT,DEF	1/1	FLY@MSL	1.18350768	0
2.137610	10/2	STAT,DEF	1/1	FLY@MSL	1.00187075	1
2.312608	10/2	STAT,DEF	1/1	FLY@MSL	1.69723141	0

1.116768	1/1	FLY@MSL	5/2	STAT,DEF	3.20290542	1
1.283436	1/1	FLY@MSL	9/2	STAT,DEF	0.18306556	1
1.283436	1/1	FLY@MSL	5/2	STAT,DEF	2.24002504	0
1.450105	1/1	FLY@MSL	9/2	STAT,DEF	1.24374771	0

APPENDIX B. PPFIRS.DAT FILE

CLOCK	FIR U/S	TGT U/S	SSKP	RANGE	TIME SUPP.
RUN31					
1.162601	1/2	1/1	0.2910	1.8006	0.041667
1.220936	3/2	1/1	0.7938	0.1867	0.041667
RUN32					
2.220942	6/2	1/1	0.0000	3.2809	0.000000
RUN33					
1.379271	4/2	1/1	0.5468	1.9336	0.041667
RUN34					
1.037600	1/2	1/1	0.2088	2.5269	0.041667
1.129268	3/2	1/1	0.7938	0.5356	0.041667
RUN35					
1.854277	2/2	1/1	0.7049	1.3359	0.041667

RUN36

1.129268	4/2	1/1	0.7938	0.3249	0.041667
1.553354	6/2	1/1	0.1253	2.5668	0.000000

RUN37

1.220936	5/2	1/1	0.2002	2.6466	0.041667
1.287603	3/2	1/1	0.7938	0.3727	0.041667
1.762609	6/2	1/1	0.4806	2.2294	0.000000

RUN38

0.912599	1/2	1/1	0.0000	3.4727	0.000000

RUN39

1.145935	1/2	1/1	0.2677	1.9768	0.000000
1.379271	5/2	1/1	0.6441	1.5659	0.041667

RUN40

1.062600	1/2	1/1	0.2286	2.3404	0.000000
1.220936	4/2	1/1	0.7938	0.8966	0.041667
1.711683	2/2	1/1	0.7938	0.4854	0.083333

RUN41

1.254269	3/2	1/1	0.0000	3.1656	0.000000
1.979279	6/2	1/1	0.0000	3.6222	0.000000

RUN42

1.137601	4/2	1/1	0.7938	0.1794	0.000000
1.204269	3/2	1/1	0.8100	0.1993	0.041667
1.354271	1/2	1/1	0.7938	0.9745	0.083333

RUN43

1.687608	5/2	1/1	0.0000	3.5386	0.000000

RUN44

1.162601	3/2	1/1	0.0000	3.1546	0.000000
1.961227	2/2	1/1	0.0000	3.8014	0.000000

RUN45

1.362604	1/2	1/1	0.0000	3.3480	0.000000
1.820944	2/2	1/1	0.0000	3.2820	0.000000

RUN46

1.179268	4/2	1/1	0.0000	3.1864	0.041667
1.445939	1/2	1/1	0.0000	3.3480	0.000000

RUN47

1.112601	4/2	1/1	0.0000	3.1525	0.000000
1.495939	1/2	1/1	0.0000	3.4114	0.000000
1.679275	2/2	1/1	0.0000	3.1687	0.000000
2.137610	6/2	1/1	0.0000	3.4438	0.000000

RUN48

1.629274	5/2	1/1	0.0000	3.4180	0.000000
1.662608	2/2	1/1	0.0000	3.1687	0.041667

RUN49

1.104267	4/2	1/1	0.0000	3.1525	0.041667
1.145935	3/2	1/1	0.0000	3.1964	0.000000
1.987612	2/2	1/1	0.0000	3.8014	0.000000

RUN50

1.070934	4/2	1/1	0.0000	3.1515	0.041667
1.320937	5/2	1/1	0.0000	3.6573	0.000000
1.745943	2/2	1/1	0.0000	3.2111	0.041667

RUN51

1.079267	42	11	0.2786	1.8942	0.041667

RUN52

1.079267	42	11	0.2788	1.8925	0.000000
1.145935	3/2	1/1	0.2750	1.9210	0.000000
1.162601	1/2	1/1	0.1962	2.6460	0.000000
2.104278	6/2	1/1	0.0000	3.4714	0.041667

NOFIRESINRUN53

RUN54

1.195935	4/2	1/1	0.5377	2.0106	0.041667
1.527828	5/2	1/1	0.0000	3.2569	0.000000

RUN55

1.237602	5/2	1/1	0.0000	3.0912	0.000000

RUN56

0.904266	1/2	1/1	0.0000	3.6220	0.000000
1.262603	3/2	1/1	0.5489	1.9257	0.041667

RUN57

1.445939	4/2	1/1	0.0000	3.6334	0.000000
2.245942	6/2	1/1	0.0000	3.2233	0.041667

RUN58

1.229269	3/2	1/1	0.5672	1.8994	0.000000
1.337604	5/2	1/1	0.3900	2.6577	0.041667
1.670942	2/2	1/1	0.0000	3.7112	0.000000

RUN59

1.070934	4/2	1/1	0.5512	1.9168	0.041667
1.162601	5/2	1/1	0.0000	3.3905	0.000000
1.779276	2/2	1/1	0.0000	3.7703	0.000000
2.129277	6/2	1/1	0.0000	3.4714	0.000000

RUN60

1.237602	5/2	1/1	0.0000	3.0912	0.041667
1.344223	3/2	1/1	0.3285	2.9479	0.041667

APPENDIX C. PPKILS.DAT FILE

CLOCK POSITION

RUN31

1.230480 (492.973, 896.574)

1.254659 (493.001, 896.816)

NO KILLS IN RUN 32

RUN33

1.478128 (493.153, 898.208)

RUN34

1.156648 (492.916, 896.178)

1.166785 (492.945, 896.376)

RUN35

1.922572 (494.818, 900.621)

RUN36

1.145877 (492.916, 896.178)

RUN37

•

1.356243 (493.044, 897.214)

NO KILLS IN RUN 38

RUN39

1.459327 (493.153, 898.208)

RUN40

1.266775 (493.023, 897.015)

1.736500 (493.942, 899.960)

NO KILLS IN RUN 41

RUN42

1.214458 (492.945, 896.376)

1.404091 (493.088, 897.612)

NO KILLS IN RUN 43

RUN44

4.306437 (496.343, 900.213)

RUN45

4.306437 (496.343, 900.213)

RUN46

4.306437 (496.343, 900.213)

RUN47

4.306437 (496.343, 900.213)

RUN48

4.306437 (496.343, 900.213)

RUN49

4.306437 (496.343, 900.213)

RUN50

4.306437 (496.343, 900.213)

RUN51

1.176105 (492.945, 896.376)

RUN52

4.306437 (496.343, 900.213)

NO KILLS IN RUN 53

RUN54

1.298726 (493.023, 897.015)

NO KILLS IN RUN 55

RUN56

1.361054 (493.088, 897.612)

NO KILLS IN RUN 57

RUN58

1.473478 (493.131, 898.009)

RUN59

1.168931 (492.916, 896.178)

RUN60

1.494935 (493.167, 898.335)

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